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100-NR-1 Treatment, Storage, and Disposal Units Engineering Study

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Prepared for the U.S. Department of Energy
Office of Environmental Restoration

Bechtel Hanford, Inc.
Richland, Washington

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Title of Document: 100-NR-1 TREATMENT, STORAGE, AND DISPOSAL UNITS ENGINEERING STUDY

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1.0 INTRODUCTION

1.1 PURPOSE

The preferred alternative in the proposed plan for the 1301-N and 1325-N Cribs/Trenches (currently undergoing regulatory review) requires the removal and disposal of contaminated material at the Environmental Restoration Disposal Facility (ERDF) (DOE-RL 1997). Various methods are available for excavation, transportation, and disposal of the material at ERDF. This study will evaluate the issues associated with the various methods, focusing on radiation exposure and safety hazards. Furthermore, the study will develop and compare options to implement the preferred alternative.

1.2 OBJECTIVES

The specific objectives for this study are as follows:

- Evaluate methods to excavate, transport, and dispose of 100-N Crib/Trench waste
- Develop remediation options based on combinations of the various methods
- Perform a dose and cost evaluation for each option
- Identify a preferred option.

1.3 REPORT STRUCTURE

This report is divided into seven main sections. Sections 1.0 and 2.0 provide the scope, objectives, and background information. Section 3.0 presents criteria to evaluate remediation options. Section 4.0 presents the basis to develop remediation options. Section 5.0 presents radiation dose evaluation and cost estimate results for each option. Section 6.0 presents issues that may need to be addressed during remedial design. Section 7.0 presents conclusions and recommendations.

2.0 BACKGROUND

2.1 1301-N CRIB AND TRENCH

The 1301-N unit is located in the 100-NR-1 Operable Unit, approximately 240 m (800 ft) from the Columbia River (Figure 2-1). The 1301-N unit is composed of two parts: a crib and a zig-zag trench. The crib area is approximately 88 m (290 ft) long by 38 m (125 ft) wide and about 1.5 m (5 ft) deep. The elevation at the bottom of the crib is 137.16 m (450 ft) above mean sea level (amsl), and the surrounding grade is approximately 138.68 m (455 ft) amsl. A sloped soil and gravel embankment forms the walls of the crib.

An underground 91-cm (36-in.)-diameter main effluent line from the 105-N lift station discharged into the crib through a 16- by 3.7-m (52- by 12-ft) concrete weir box, which was initially open on top. The weir box, commonly referred to as the "horse trough," was designed to fill and then overflow into the crib. Also discharging into the crib was an underground 30-cm (12-in.)-diameter effluent drain line from the N Reactor basin floor drains.

The bottom of the crib was initially filled with a 0.9-m (3-ft) layer of large boulders. In early 1981, an additional 0.6-m (2-ft) layer of smaller boulders was added to the top of the large boulders to cover surface contamination. This layer started near the weir box and extended northeast approximately 31 m (100 ft) along the length of the crib. During August and September 1988, the entire crib was covered with cobble-sized material to an additional depth of 1.2 to 1.5 m (4 to 5 ft) (BHI 1996). Consequently, for remedial design purposes, the actual depth of the rocks and boulders may vary throughout the crib from as little as 2.1 m (7 ft) to as much as 3.4 m (11 ft).

The 1301-N zig-zag trench was constructed in 1965 and is 490 m (1,600 ft) long by 3 m (10 ft) wide at the bottom and 3.7 m (12 ft) deep with sloped side walls. Water spilled over the weir in the dike on the north side of the crib into the trench. Boulders and cobbles were not placed in the trench as they were in the crib. Wooden poles laid across the trench were used to support wire screen to prevent bird intrusion.

In early 1982, precast concrete panels were installed to cover the trench to minimize wildlife intrusion and airborne contamination. These panels created a 15-m (50-ft)-wide cover over the top of the trench. The panels are supported by concrete foundations and beams; the panels span the trench. The wooden poles and wire mesh were left in place. The gap between the ends of the cover panels and the trench walls was backfilled to prevent wildlife intrusion. The joints between adjacent panels, extending across the trench along the support beams, were grouted. After backfilling, the side slopes outside the cover were sprayed with a layer of shotcrete to prevent erosion and rodent intrusion.

In 1995, a limited field investigation was performed. Part of the scope of this investigation was to drill an exploratory boring in the 1301-N Crib to determine potential impacts to groundwater from crib contamination. Site preparation for drilling consisted of placing a drill pad that consists of 0.61 m (2 ft) of clean fill over part of the crib to provide shielding during drilling operations. This drill pad material was included in contaminated volume calculations presented in this report.

2.2 1325-N CRIB AND TRENCH

Routine sampling of riverbank springs in 1982 showed an increase in radionuclide concentrations reaching the river, indicating reduced effectiveness of the 1301-N unit to retain radionuclides in the soil column. This sampling led to the construction of the 1325-N Crib. To transfer effluent to 1325-N, the 1301-N weir box was modified by adding two 91-cm (36-in.)-diameter, discharge pipelines (opposite the inlet lines) and a cover.

The 1325-N unit was also comprised of two parts: a crib and a straight trench. The 1325-N Crib was constructed and operational in October 1983 as a replacement for the 1301-N unit that had reached its disposal capacity. The 1325-N unit operated until April 1991, and the unit was dismantled in 1993. The 1325-N unit is located approximately 300 m (1,000 ft) east and 61 m (200 ft) north of the 1301-N unit (Figure 2-1).

The 1325-N Crib is 76 by 73 m (250 by 240 ft) and has a concrete cover positioned about 4 m (13 ft) below the surrounding surface grade, which is about 137 m (451 ft) amsl. The cover is made of precast concrete panels with grout-sealed joints.

Effluent was delivered to the 1325-N Crib through a 366-m (1,200-ft)-long by 91-cm (36-in.)-diameter pipeline. A reinforced concrete-header, box-and-trough system distributed the effluent in the 1325-N Crib. Effluent entered from the 91-cm (36-in.) pipeline into the main distribution trough that runs down the center of the crib. The effluent flowed through holes in the sides of the main distribution trough into the distribution laterals. Similar holes in the sides of the distribution laterals allowed the effluent to evenly discharge to the soil column.

The 1325-N Crib did not achieve its designed flow capacity because of low percolation rates in the soil column; therefore, the 1301-N unit was used as an alternate discharge point to prevent the 1325-N Crib from overflowing (BHI 1996). During October and November 1983, the crib's capacity was exceeded two or three times causing it to overflow. Each overflow traveled no more than 6.1 to 9.1 m (20 to 30 ft) from the crib's concrete cover. All contamination stayed within the fenced boundary, and each overflow was covered with a 15- to 20-cm (6- to 8-in.) layer of clean 2.5- to 5-cm (1- to 2-in.) river rock. After these initial incidents, the flow to 1325-N was controlled to prevent any further overflows.

Construction of the 1325-N straight extension trench started 3 months after the crib began operation (BHI 1996). The 1325-N straight extension trench was operational in September 1985. The trench is 914 m (3,000 ft) by 16.8 m (55 ft) and is 3.05 m (10 ft) deep from the bottom of the concrete panels to the soil percolation surface, which is at an elevation of 133.2 m (437 ft) amsl. This trench is also covered with precast concrete panels placed close together, but left unsealed; the panels have lifting lugs. Centracore™ concrete panels measuring 0.6 m (2 ft) by 20.3 cm (8 in.) were placed unsealed along the sides of the trench. The sides of the trench were backfilled, which created a minimum barrier of 0.9 m (3 ft) for burrowing animals.

The trench is divided into four equal sections by three dams. Only the first 226 m (740 ft) of the 1325-N Trench were used, as effluent levels never rose high enough to cross the first dam. The dams are composed of structural fill and concrete. A layer of riprap was added on the downstream side of each dam to prevent scouring. The top 0.6 m (2 ft) of the trench bottom was dredged periodically to remove the fines to enhance percolation and reduce plugging.

In September 1985, 1325-N became the primary liquid waste disposal facility at 100 N, and 1301 N was used only as an emergency discharge point. In December 1986, N Reactor was placed on standdown status for an extended maintenance and safety upgrade. Thus, discharges to 1325 N decreased significantly and ceased in April 1991.

2.3 LIMITED FIELD INVESTIGATION AND CORRECTIVE MEASURES STUDY RESULTS

A limited field investigation (LFI) (DOE-RL 1996a) was conducted in 1995 to investigate the contaminant and moisture distribution in soil beneath the 1301-N and 1325-N units. Three boreholes (199-N-107A, 199-N-108A, and 199-N-109A) were drilled at the facilities (Figure 2-2). Borehole 199-N-107A was drilled within the 1301-N Crib, while boreholes 199-N-108A and 199-N-109A were drilled adjacent to the 1301-N Trench and 1325-N Crib, respectively. The analytical results from the boreholes are presented in Appendix A.

Field investigations showed that soil contaminant concentrations were highest near the base of the facilities and decreased dramatically with depth. Principal radionuclides were the same at both 1301 N and 1325 N and include cobalt-60, cesium-137, strontium-90, europium-152, europium-154, tritium, and plutonium-239/240. Chemical contamination (nitrate, mercury, and chromium in 1301-N) may also be present.

In addition to the LFI boreholes, historical operations' data from the surface samples taken from 1980 to 1985 were used to support the LFI (DOE-RL 1996a). The quality of these data cannot be determined due to a lack of QA/QC documentation; however, these data were still used to support this study. However, additional sampling must be implemented in the design phase to confirm the surface sample values. Locations for these samples are shown in Figure 2-3, and the analytical results are presented in Appendix A.

A corrective measures study (CMS) dose estimate showed higher radiation exposure to workers for the 1301-N and 1325-N Crib/Trench remediation as compared to other 100 Area remediations. Based on the evaluation of the data, it was determined that cesium-137 and cobalt-60 are the radionuclides of concern for gamma-emitting radiation. Cobalt-60 and cesium-137 are considered to be the major contributors of the external radiation sources, thus providing the majority of exposure to workers, especially during excavation/remediation. Plutonium-239/240 and strontium-90 are the radionuclides of concern for airborne contamination.

2.4 CONCEPTUAL MODELS

The conceptual models presented in the CMS identified a zone of contamination targeted for excavation. This study uses the data from the CMS to further develop the layers of contamination to be excavated.

2.4.1 Typical Contamination Layer

While developing this engineering study, it became evident that ERDF operational constraints may be the dominant factors in developing approaches to remediate the sites. Airborne contamination is the constraint for ERDF operations. Calculations showed that plutonium and strontium were dominant contributors for airborne contamination. Therefore, the team evaluated the available data to determine if there was any obvious layering of plutonium and strontium in the waste zone.

A review of the data collected reveals that limited information is available on the layer of waste that is targeted for excavation (the 1.5-m [5-ft]-thick layer of sediment and soil directly below the cribs and trenches). Surface samples are available for only the 1301-N Trench and the 1325-N Crib. One surface sample data point was eliminated because it did not represent the average contamination present in this layer (based on upstream concentration levels during N-Reactor operations). However, it may represent a "hot spot," which would be further characterized and dealt with during remedial design.

Only one borehole, 199-N-107A, was drilled through the layer of waste targeted for crib and trench excavation with three samples taken in the zone of interest of this study. The other boreholes from the LFI were not considered because the placement of these boreholes was outside the cribs and trenches and did not represent the waste in the zone of interest. The 199-N-107A samples were taken starting at a depth of 0.3 m (1 ft) below crib soil surface to 1.5 m (5 ft) below.

Therefore, this study assumes that an average value of the 1301-N Trench surface sample results represents the upper 0.3-m (1-ft) layer of contamination. This has been labeled as the high-activity layer (average plutonium-239/240 from 1301-N Trench data used in study is 41,000 pCi/g). An average of the three sample results taken from the borehole represents the next 1.2-m (4-ft) layer of contamination in all of the cribs and trenches. This has been labeled as the low-activity layer (average plutonium-239/240 used is 1,900 pCi/g).

A typical contamination zone was developed using the available analytical data (as mentioned above) and the following assumptions:

- The bottom width of the contaminated layer is the same as the width of the trench at the operating water level.

- The depth of the contamination layer is 1.5 m (5 ft) from the bottom of the crib and trench (except for 1301-N Crib; the bottom of the crib starts below the (9 ft) of boulders).

- The contamination extends from the bottom width upward at 1.5:1 slope and intersects the horizontal line of the operating water level.

Figure 2-4 presents the typical cross section for the contamination layers used to calculate contaminated volumes targeted for excavation. This typical section was applied to the 1301-N and 1325-N Cribs and Trenches. Figure 2-4 also presents the average concentrations used for each layer. Figures 2-5 and 2-6 show how the typical cross section is applied to the crib and trench areas.

2.4.2 1301-N Crib

The 1301-N Crib will be excavated to a depth of 4.6 m (15 ft) below surrounding grade. The surrounding grade is at an elevation of 138.68 m (455 ft) amsl; therefore, the bottom of the excavation will be at 134.11 m (440 ft) amsl (Figure 2-7). The low-activity soil is in a layer from 134.11 to 135 m (440 to 444 ft) amsl, while the high-activity soil is in a layer from 135 to 135.7 m (444 to 445 ft) amsl. The layer of boulders on top of this varies in thickness, but was assumed to be 2.7 m (9 ft) thick over the entire area of the crib. The lower 1.5-m (5-ft) layer of boulders is assumed to have high-activity contamination, while the upper 1.2-m (4-ft)-thick layer is assumed to have low-activity contamination.

2.4.3 1301-N Trench

The 1301-N Trench is a separate structure from the 1301-N Crib. The trench is a long, narrow excavation with shallow, sloping sides (1.5:1.0). As shown in Figure 2-3, the surrounding grade level in this area is approximately 138.68 m (455 ft) amsl. The low-activity contaminated soil below the trench extends from 132.37 to 133.6 m (434 to 438 ft) amsl, while the high-activity contaminated soil layer extends from 133.6 to 133.8 m (438 to 439 ft) amsl. Concrete panels cover the trench at an elevation of 138.1 m (453 ft) amsl.

2.4.4 1325-N Crib

The 1325-N Crib will be excavated to a depth of 4.6 m (15 ft) below surrounding grade. The surrounding grade is at an elevation of 137.5 m (451 ft) amsl; therefore, the bottom of the excavation will be at 132.9 m (436 ft) amsl (Figure 2-8). The low-activity soil is in the layer from 132.9 to 134.2 m (436 to 440 ft) amsl, while the high-activity soil is in the layer from 134.2 to 134.5 m (440 to 441 ft) amsl. The crib is covered with concrete panels at an elevation of 136.3 m (447 ft) amsl.

2.4.5 1325-N Trench

The 1325-N Trench is a long, narrow trench with shallow sloping sides (1.5:1.0). As shown in Figure 2-8, surrounding grade level in this area is approximately 137.5 m (451 ft) amsl. The low-activity contaminated soil below the trench extends from 131.7 to 132.9 m (432 to 436 ft) amsl, while the high-activity contaminated soil layer extends from 132.9 to 133.2 m (436 to 437 ft) amsl. Concrete panels cover the trench at an elevation of 136.3 m (447 ft) amsl.

Figure 2-1. 1301-N and 1325-N Crib/Trench Locations.

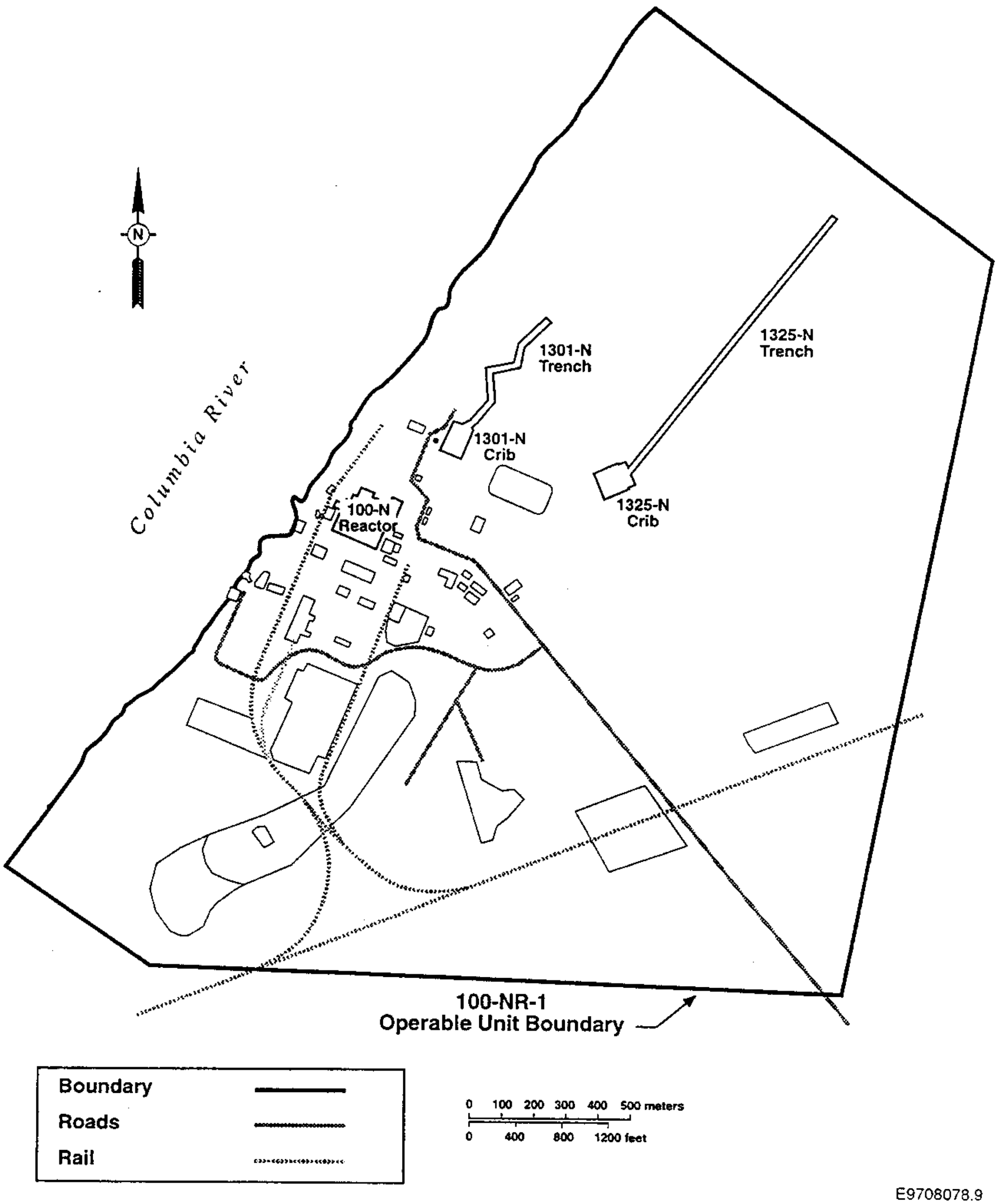


Figure 2-2. Limited Field Investigation Borehole Locations for 1301 N and 1325 N.

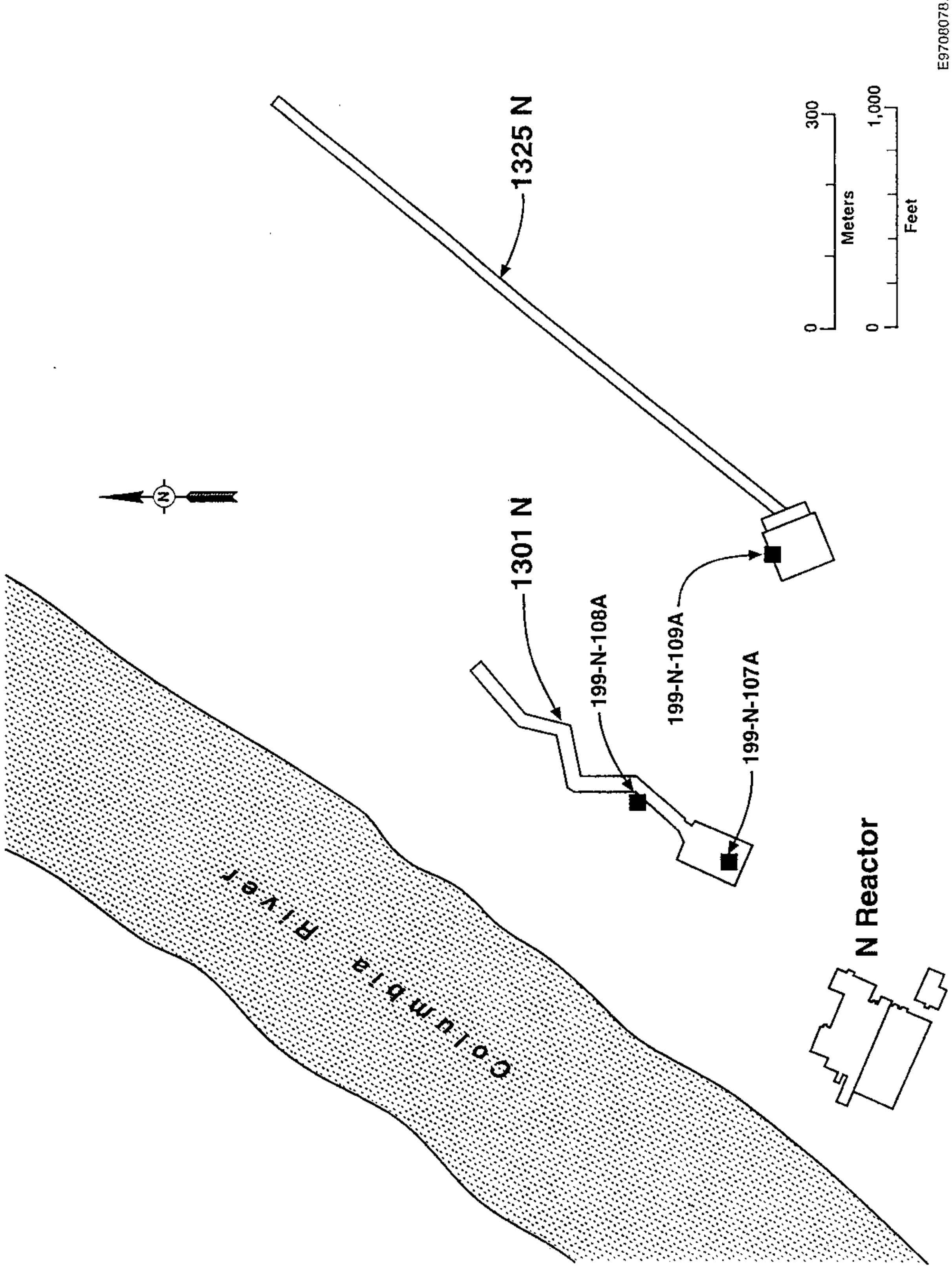
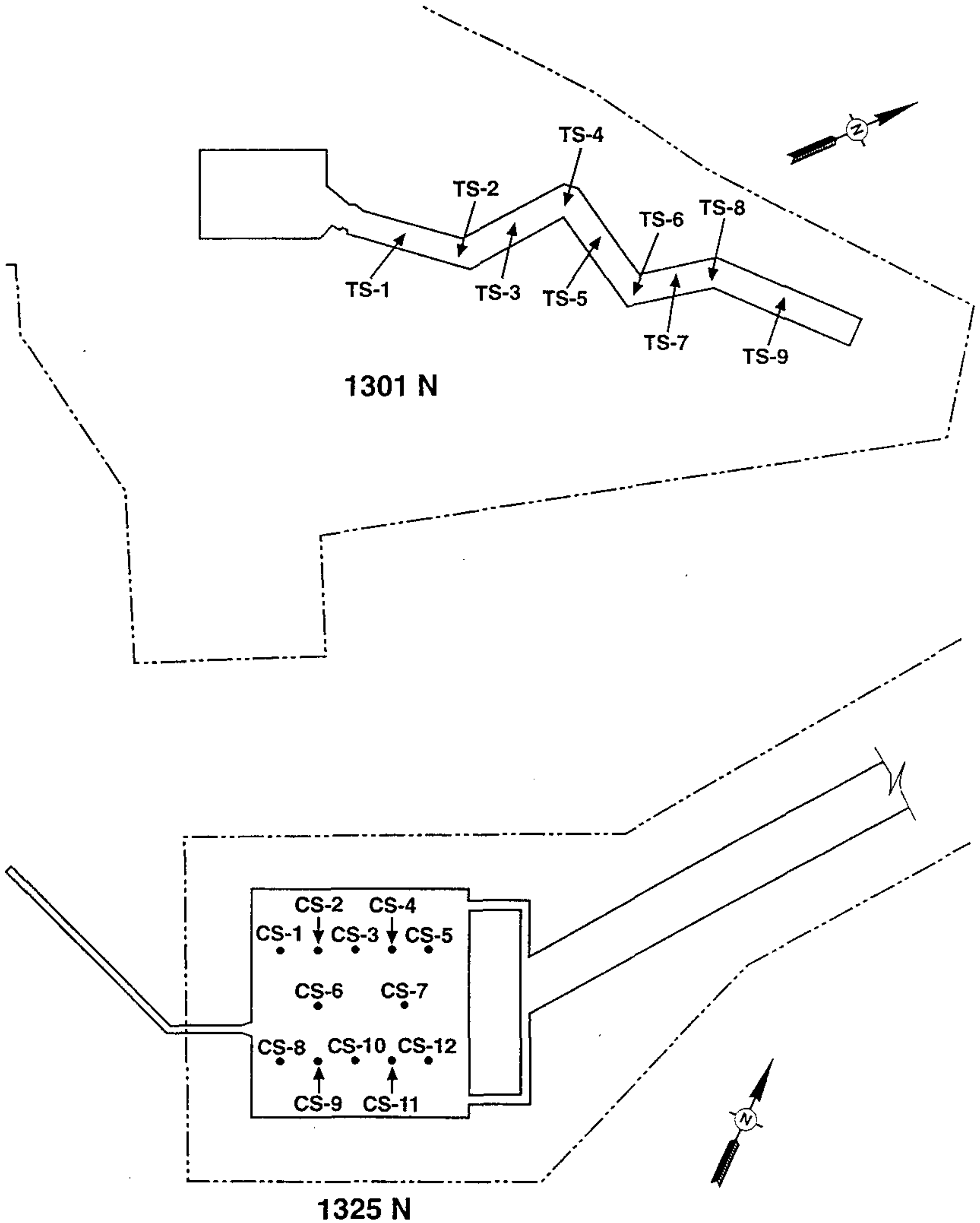


Figure 2-3. 1301-N Trench and 1325-N Crib Surface Sample Locations.



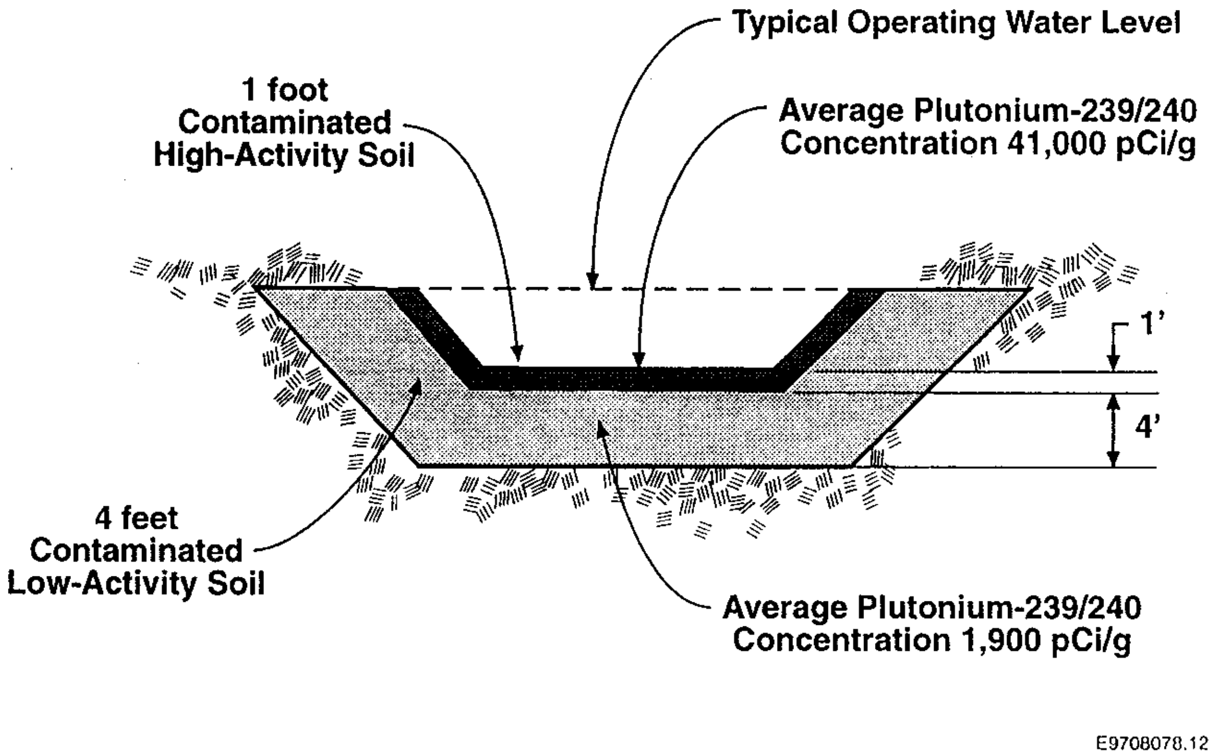
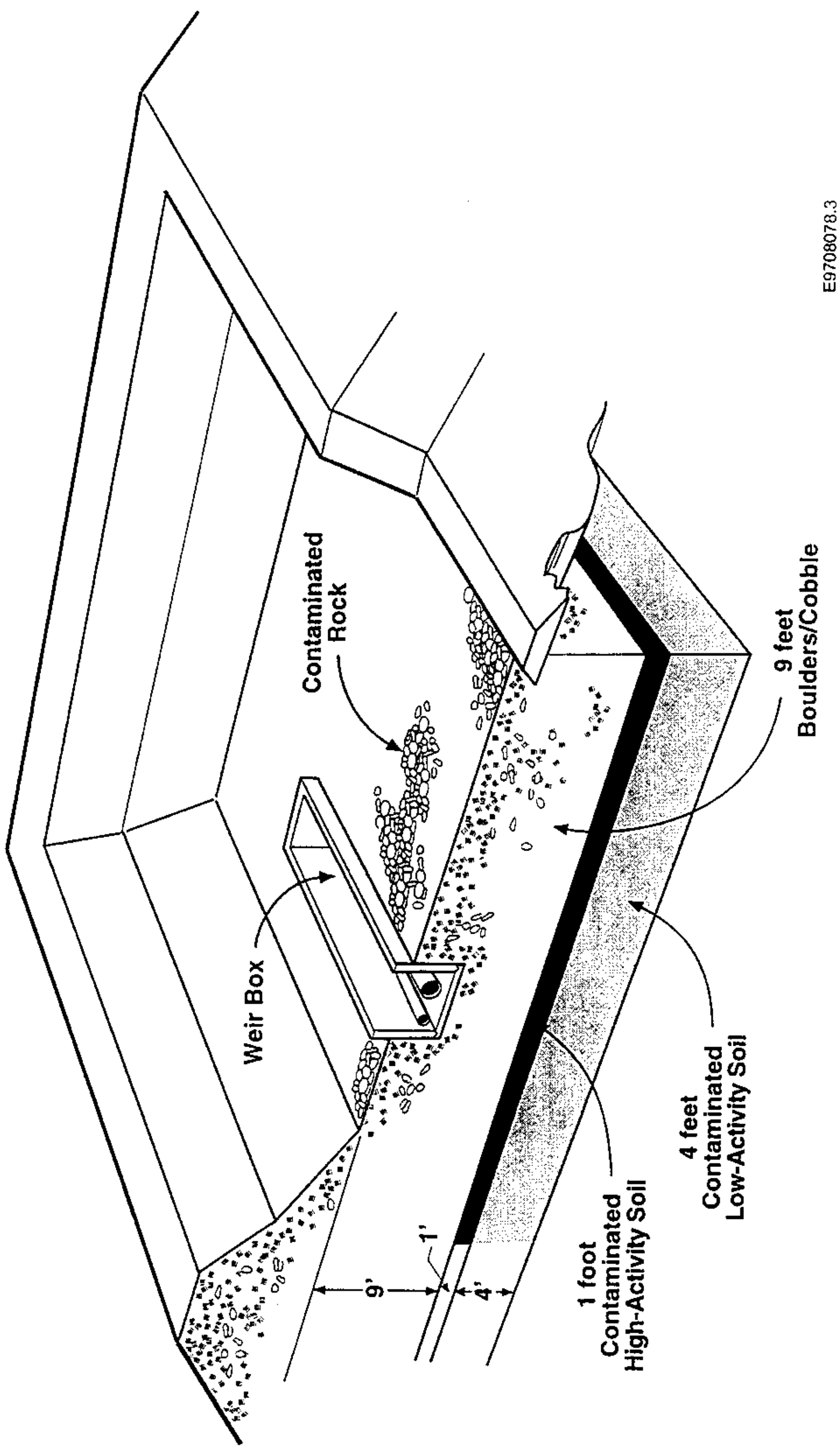


Figure 2-4. Typical Contamination Cross Section.

Figure 2-5. Crib Model Used for Volume Calculations.



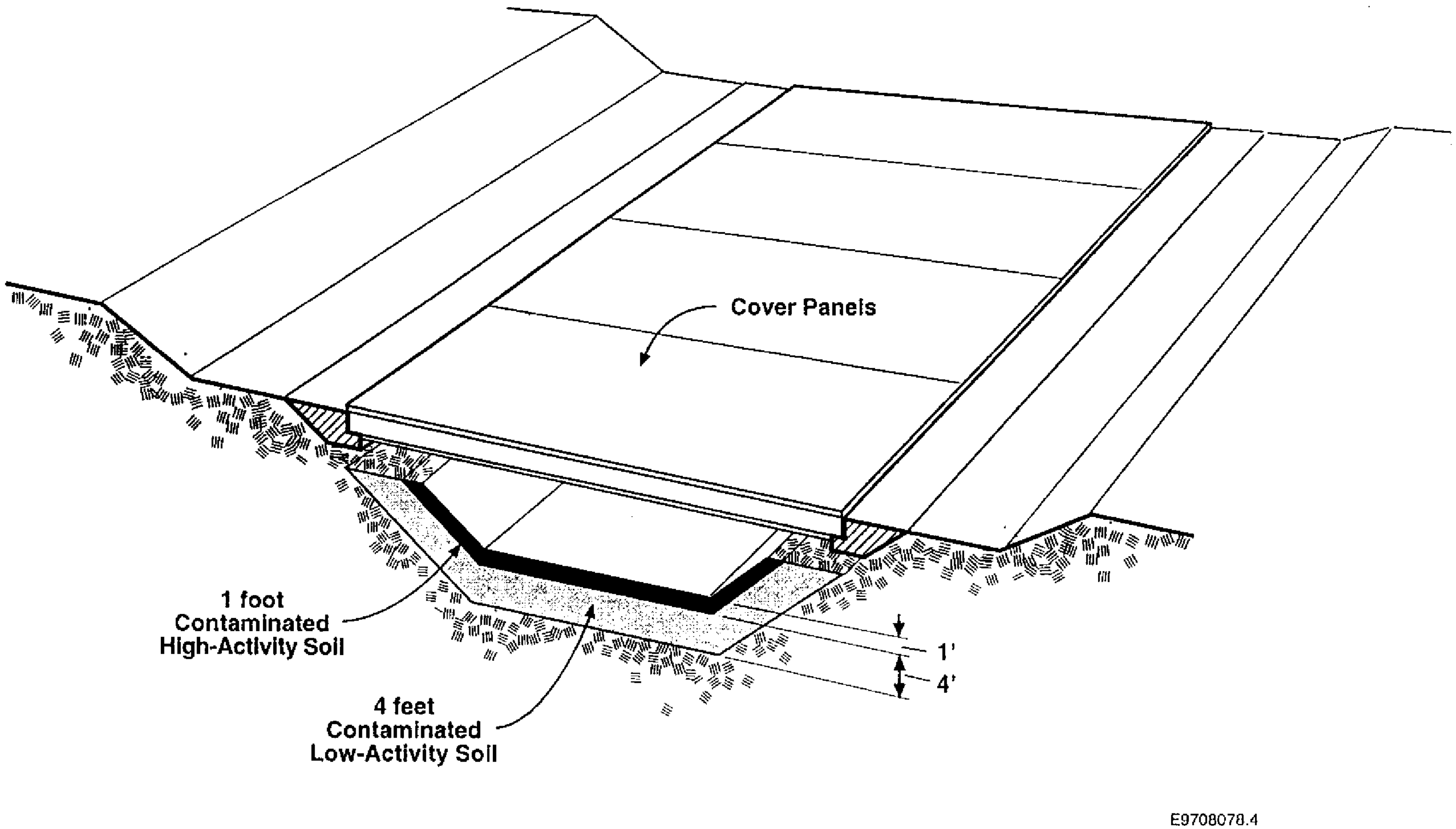


Figure 2-6. Trench Model Used for Volume Calculations.

Figure 2-7. 1301-N Crib and Trench Cross Section.

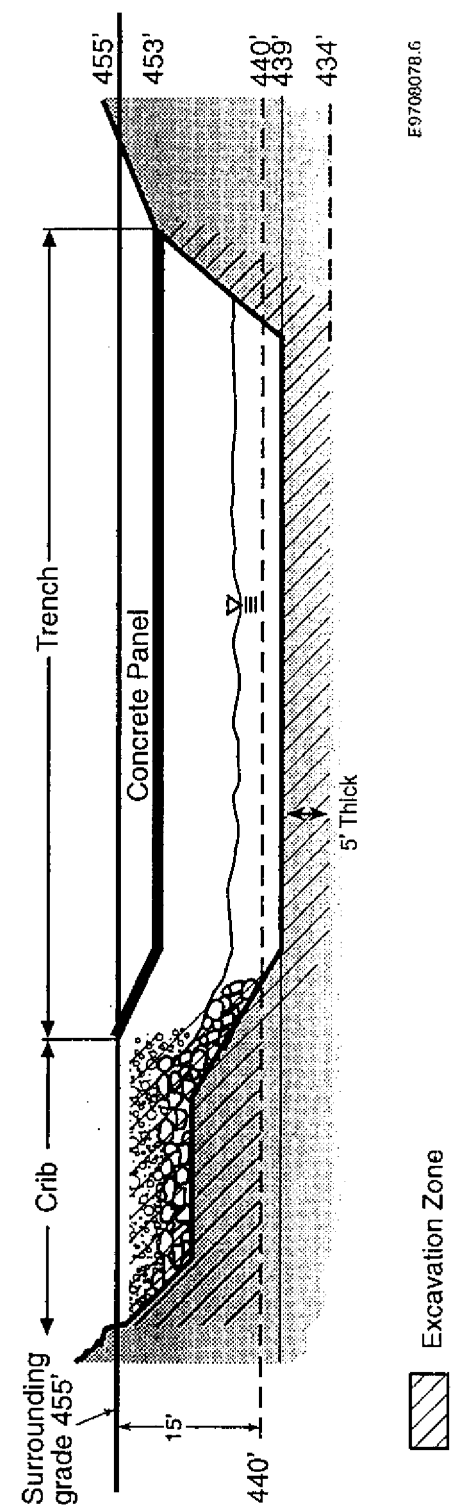
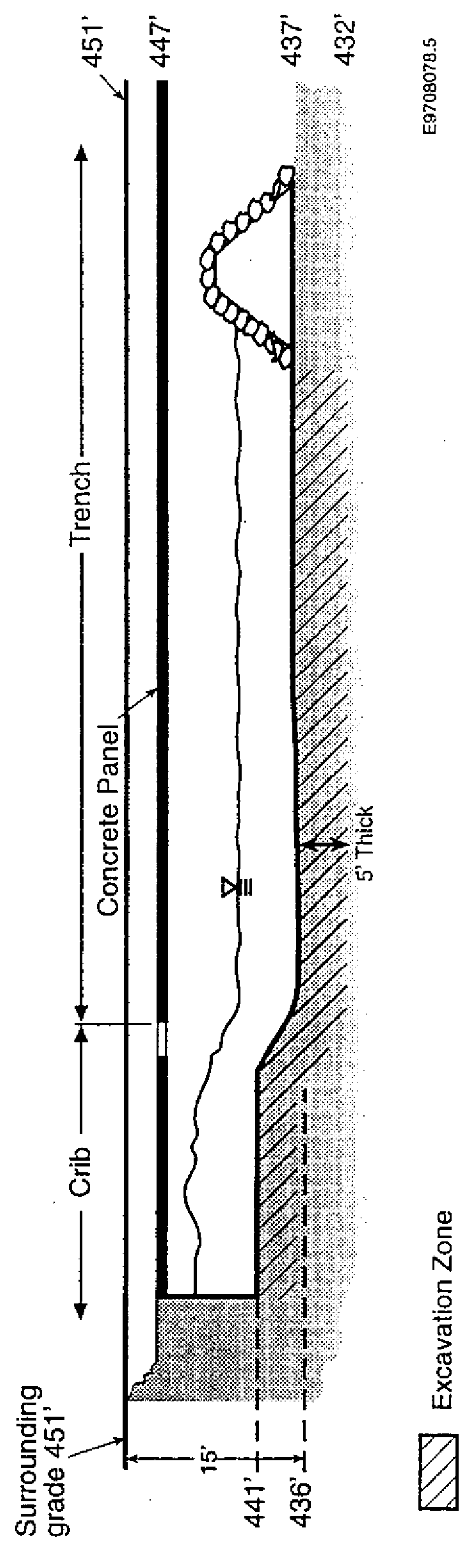


Figure 2-8. 1325-N Crib and Trench Cross Section.



3.0 CRITERIA FOR REMEDIATION OPTIONS EVALUATION

3.1 VALUE ENGINEERING METHODOLOGY

This study used value engineering techniques to support development of remediation options, and, subsequently, select the most cost-effective option for remediation.

Two of the three major stages of a typical Value Engineering Study were used, as presented below:

- **Prestudy (Planning) Stage**: The team members were briefed on the project, expectations outline, and specific responsibilities to execute the study.

- **Job Plan (Study) Stage**: This stage consists of a five-phase study process.

  1. Investigation Phase: The following tasks were performed:

     a. Review and discuss information provided by the project and/or gathered by team members during the prestudy stage

     b. Identify major functions of the system and/or task and function relationships (Figure 3-1)

     c. Establish and/or estimate cost of each major function

     d. Select specific functions for examination.

  2. Speculative/Creative Phase: The team discussed and generated creative ideas to achieve the required functions.

  3. Evaluation/Analysis Phase: The study team evaluated all ideas and eliminated the ideas/options that are not feasible and do not satisfy project requirements. The remaining ideas/options will be ranked in the order of feasibility and life-cycle cost.

  4. Development/Planning Phase: The study team developed the best remediation options.

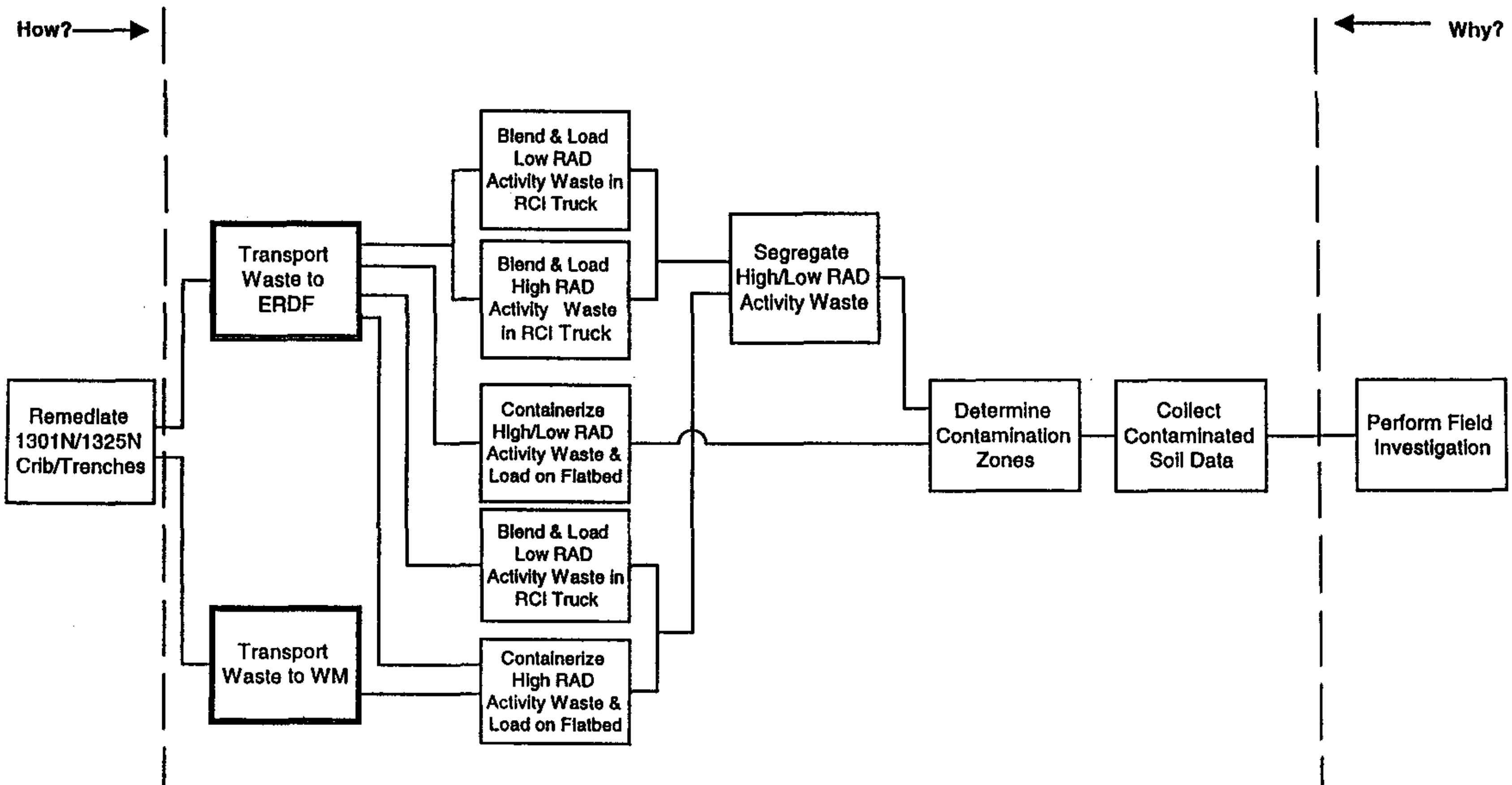
  5. Presentation Phase: Appropriate documentation of the study results will be prepared for presentation.

- **Implementation Stage**: (Not part of this study, applies to design and remedial action phase.)

3.2 VALUE ENGINEERING CRITERIA

The team developed eight criteria to evaluate each option (Figure 3-2), with the first criterion being a general evaluation of how well each option would satisfy all the criteria combined. All the criteria, except the first, were compared using the Value Engineering-Paired Comparison technique to determine a hierarchy. The dominant criterion was then assigned a relative value from 1 to 4, with 1 being no preference and 4 being a major preference between the two criteria. The resulting relative scores were totaled. The criteria were then ranked by their total relative score. These relative scores determine the weighting of each criteria to evaluate the options.

Each option was ranked against each criterion. The ranking for each option was summed to determine a total score. The results are provided in Figure 3-3. The alternatives that achieved a ranking better than 327 (calculated by assigning a "Good" rating in each category) were carried forward for calculating life-cycle costs.



ERDF = Environmental Restoration Disposal Facility
WM = Waste Management Disposal Facility

Figure 3-1. Remediation of 1301-N/1325-N Crib/Trenches.

Figure 3-2. Criteria Weighting Process.

PROJECT :100 - N TSD Remediation

CRITERIA	RAW SCORE (WEIGHT)
A. RADCON	19
B. Simplicity of Operation	0
C. Lowest Life-Cycle Cost	15
D. Least Environmental Impact	4
E. Best Meets Schedule	8
F. Worker Safety/Dose to Worker	23
G. Most Flexible System to Operate	8
H. Least Stand-by Time	9

How Important

4 - Major preference
3 - Medium preference
2 - Minor preference
1 - Letter/Letter - no preference
each scored one point

	B	C	D	E	F	G	H
A	A4	A3	A2	A3	F1 A1	A3	A3
	B	C4	D3	E4	F4	G3	H3
		C	C4	C3	F3	C4	H2
			D	E2	F4	G1 D1	H3
				E	F4	E1 G1	E1 H1
					F	F3	F4
						G	G3

Figure 3-3. Matrix Weighting of Alternatives.

PROJECT: 100-NR-1 TSD ENGINEERING STUDY
LOCATION: HANFORD SITE, RICHLAND, WA
STUDY: OPTIONS FOR EXCAVATION, PACKAGING, AND DISPOSING TSD WASTE

CRITIERIA / OPTIONS	Satisfies Function	Worker Safety/Dose	RADCON	Lowest Life-Cycle Cost	Least Standbye Time	Best Meets Schedule	Most Flexible to Op	Least Envr Impact	Total Weighted Value	Desirability Rank
Rel. Wgts	23	23	19	15	9	8	8	4		
1. Blend to meet ERDF 270 pCi/g limit	1.0									
2. Blend all Wst to 2000 pCi/g Limit	3.0 / 69	3.0 / 69	4.0 / 76	4.0 / 60	2.5 / 23	4.0 / 32	4.0 / 32	2.0 / 8	369	2
3. B25 Containers for High Activity Blend LA Wst to 2000 pCi/g Limit	4.0 / 92	4.0 / 92	3.5 / 67	5.0 / 75	4.5 / 41	5.0 / 40	4.0 / 32	4.0 / 16	454	1
4. High Activity to Wst Man Blend LA Wst to 2000 pCi/g Limit	3.5 / 81	4.0 / 92	3.0 / 57	3.5 / 52.5	2.0 / 18	3.0 / 24	3.0 / 24	4.0 / 16	364	3
5. Containerize all Waste in B25s	3.0 / 69	3.5 / 81	2.5 / 48	3.0 / 45	2.5 / 23	2.5 / 20	5.0 / 40	5.0 / 20	345	4

RANK VALUE: 5-Excellent 4-Very Good 3-Good 2-Fair 1-Poor

4.0 REMEDIATION OPTIONS

4.1 REMEDIATION ISSUES

The remediation options presented in the following subsections were developed by Environmental Restoration Contractor staff from the Engineering, Field Support, Radiological Engineering, Sample/Data Management, Transportation, and Waste Disposal organizations. The project team examined issues related to excavation, transportation and disposal, and how these systems can support remediation of the cribs and trenches. Issues evaluated included personnel safety, airborne contamination, site access, radiation exposure (dose), handling of concrete panels, debris, and contaminated boulders. Based on the project team's evaluation, the following two issues had the most impact on the development of the remediation options:

- High radiation exposure during remediation
- ERDF operational constraints.

Five remediation options were developed consistent with the remove and dispose remedial alternatives presented in the draft proposed plan for the cribs/trenches.

4.2 HIGH RADIATION EXPOSURE

Cobalt-60 and cesium-137 provide high-energy gamma radiation that could contribute significant dose to workers. Therefore, a common denominator for all issues related to removal, excavation, transportation, and disposal was the management of the dose to workers during each operation. Dose is managed by applying three factors: time, distance, and shielding. Examples of applying these factors during the development of remediation options are as follows: (1) providing shielded areas where workers can minimize their exposure to radiation, (2) selecting equipment with longer booms to increase distance between workers and contamination, (3) using cranes to handle high-activity packages to provide more distance, (4) placing a layer of soil on the top of contamination area to provide a working surface for equipment and shielding for workers, and (5) using shielding on excavators, forklifts, and trucks.

4.3 ERDF OPERATIONAL CONSTRAINTS

The study team determined that allowable airborne concentrations would be a limiting operating factor for disposing 1301-N and 1325-N Crib and Trench waste at ERDF. Therefore, an alpha-emitting airborne concentration limit was calculated based on plutonium-239/240. It was assumed that ERDF would receive waste from other areas during remediation of the 1301-N and 1325-N Cribs and Trenches. The volumes of waste material from these other areas were assumed to be two-thirds of the total receipts at ERDF, with the remaining one-third coming from 1301-N and 1325-N Crib and Trench remediation.

The worst-case operation scenario at ERDF would involve 600 $\mu g/m^3$ of dust in the worker's breathing zone for 500 hr/yr. At this dust level a concentration of 270 pCi/g of plutonium-239/240 will result in an airborne level that is 9% of a derived airborne concentration (DAC) and deliver 100 mrem/yr to the worker. Studies have shown that standard construction work can produce dust loading of this magnitude. Therefore, the 270 pCi/g limit was used for existing ERDF operations that are similar to standard construction operations.

Another option for ERDF operations was developed by raising the plutonium soil concentration limit, which could be accomplished by increasing operational requirements at ERDF. Operational controls that would be required to raise the limit could consist of increased dust control measures, strategic placement of waste at ERDF and workers handling this material, increased coordination of all other waste delivered to ERDF, increased monitoring of dust loading, and containerization of high-activity material. Therefore, 2,000 pCi/g (plutonium-239/240) was calculated as an upper bound limit based on failures of airborne control requirements creating conditions that exceed posting and respiratory protection requirements. Limits higher than 2,000 pCi/g (plutonium-239/240) would require ERDF personnel to wear respiratory protection while disposing waste. However, it is desirable to avoid using respiratory protection based on industrial health and safety consideration involving heat stress, vision impairment, communication impairment, and reduced worker efficiency. In addition, 10 CFR 835, sec. 835.1002(c), states "Regarding the control of airborne radioactive material, the design objective shall be, under normal conditions, to avoid releases to the workplace atmosphere and in any situation, to control the inhalation of such material by workers to levels that are ALARA; ..."

The 2,000 pCi/g (plutonium-239/240) limit is based on dust loading measurements. Dust loading measurements at ERDF require maintaining dust levels below the upper limit of 100 $\mu g/m^3$ with an average loading of 50 $\mu g/m^3$ to workers. In these conditions, 2,000 pCi/g of alpha-emitting isotopes could safely be handled without exceeding target airborne concentrations during normal operating conditions. This is an acceptable value since a severe failure (dust loading of up to 1,000 $\mu g/m^3$) in engineering controls will result in an airborne concentration just at 1 DAC. As a result, respiratory protection will not be required for ERDF personnel.

4.4 REMEDIATION OPTIONS

Remediation options were developed by engineering, field support, radiological, and sampling management staff. The options presented in the following sections are all supported by the same excavation, concrete/debris, and cobble/boulder removal methods. Sections 4.4.1 through 4.4.3 describe these methods.

4.4.1 Excavation

Excavation would be accomplished by using a trackhoe excavator equipped with an extended reach boom. Side slope benching along the trench shall be performed, as necessary, to position the trackhoe, establish a laydown area, and permit transportation of packaged material (B-25 boxes or roll-on/roll-off containers). The trackhoe operator would start excavation at the side of the trench and/or crib and remove material from the bottom and side slope. When the reach of the boom is exceeded, soil cover will be placed on top of the exposed surfaces to reduce dose exposure and provide a surface for the excavator to relocate to continue removing material. Excavated material will be placed and packaged in either ERDF roll-on/roll-off containers or B-25 boxes. These containers will be staged for transport to ERDF.

4.4.2 Removal of Concrete Panel and Debris

Concrete panels, structural supports, and large debris will be rigged for crane removal and monitored for contamination. Removal of concrete panels and supports will be consistent with the excavation, limiting the amount of trench exposed unprotected. Material not directly in contact with the soils of the trench will be surveyed and decontaminated, as required (reasonable determination made in the field), and clean material will be staged for alternate disposal. Contaminated material will be sized in accordance with ERDF bulk waste supplemental criteria and transported to ERDF for disposal. Smaller concrete material and debris in contact with the soils or requiring significant decontamination efforts will be removed by the excavator and placed in the appropriate package or container for disposal at ERDF.

4.4.3 Cobble and Boulder Removal

Cobble and boulder layers comprise the upper most region of the 1301-N Crib area to be remediated. The cobble layer is considered low level and will be excavated into roll-on/roll-off containers and transported to ERDF. During the excavation of the cobble, a layer of cobble will remain to provide shielding while removing the high-activity material (boulders and soil beneath the boulders). High-activity material will be packaged directly into containers (B-25 boxes) without blending or will be proportionally blended with low-level soil into roll-on/roll-off containers.

4.4.4 Option 1: Mix High- and Low-Activity Material to Meet 270 pCi/g Soil Concentration Limit

This option consists of mixing the higher and lower activity material to meet the soil concentration limit of 270 pCi/g (plutonium-239/240). This mixing will reduce soil concentrations to address airborne contamination dose to workers. It is assumed that lower activity material from other sites and onsite materials from crib/trench excavation operations will be used for mixing to meet this limit. Mixing operations will consist of excavating and placing a predetermined amount of higher activity crib/trench soil in a standard transport container (RCI container) and subsequently placing a predetermined amount of lower activity stockpiled soil in the container. Once the container is filled, it will be transported to ERDF for free dumping. Excavation operations for this option will require the placement of clean and/or lower activity soil on the crib/trench surface soils for shielding during excavation. Figure 4-1 presents this option. However, this option was not carried forward, based on the Value Engineering Study results presented in Section 3.0.

4.4.5 Option 2: Increase Soil Concentration Limit to 2,000 pCi/g

This option introduces operational controls for airborne contamination at ERDF so that ERDF soil concentration limits can be increased to 2,000 pCi/g for plutonium-239/240. The same mixing and shielding operations will apply from Option 1; however, the increased limit will lessen the amount of mixing that will be required. Figure 4-1 presents this option.

4.4.6 Option 3: Containerize (Package) the High-Activity Material and Mix Low-Activity Material to Meet 2,000 pCi/g Limit

This option packages the higher activity material in B-25 boxes for shipment to ERDF. The excavation approach will be the same as Option 2. Containing the high-activity waste in B-25 boxes eliminates the potential for airborne contamination; however, dose considerations will need to be managed. The lower activity material will be mixed to achieve a volume that will decrease the potential for airborne contamination and will be placed in existing ERDF containers (RCI containers). The handling process will also reduce the gamma dose rates produced by the waste. The approach to excavation and shielding will be the same as Option 1. Figure 4-2 presents this option.

4.4.7 Option 4: Containerize (Package) the High-Activity Material for Shipment to Waste Management and Mix Low-Activity Material to Meet 2,000 pCi/g Soil Concentration Limit

This option is the same as Option 3, except that the high-activity waste contained in the B-25 boxes will be shipped to Waste Management while the lower activity material will be shielded, excavated, mixed, and shipped to ERDF. Figure 4-2 presents this option.

4.4.8 Option 5: Containerize (Package) All Material

This option will contain all waste in B-25 boxes (both high and low activity waste) for shipment to ERDF. Figure 4-3 presents this option.

4.5 CONTAMINATED SOIL VOLUMES FOR REMEDIAL ACTION

Table 4-1 presents the results of the volume of contaminated soils from the 1301-N and 1325-N Cribs and Trenches. These volumes were calculated based on the conceptual model descriptions of the cribs and trenches presented in Section 2.0. Appendix B presents the calculation package that was used to generate Table 4-1. Table 4-2 presents the volume of contaminated soils that will be generated through mixing and containerizing waste for each remediation option. Each option in this table also provides the mixing ratio used to generate volumes.

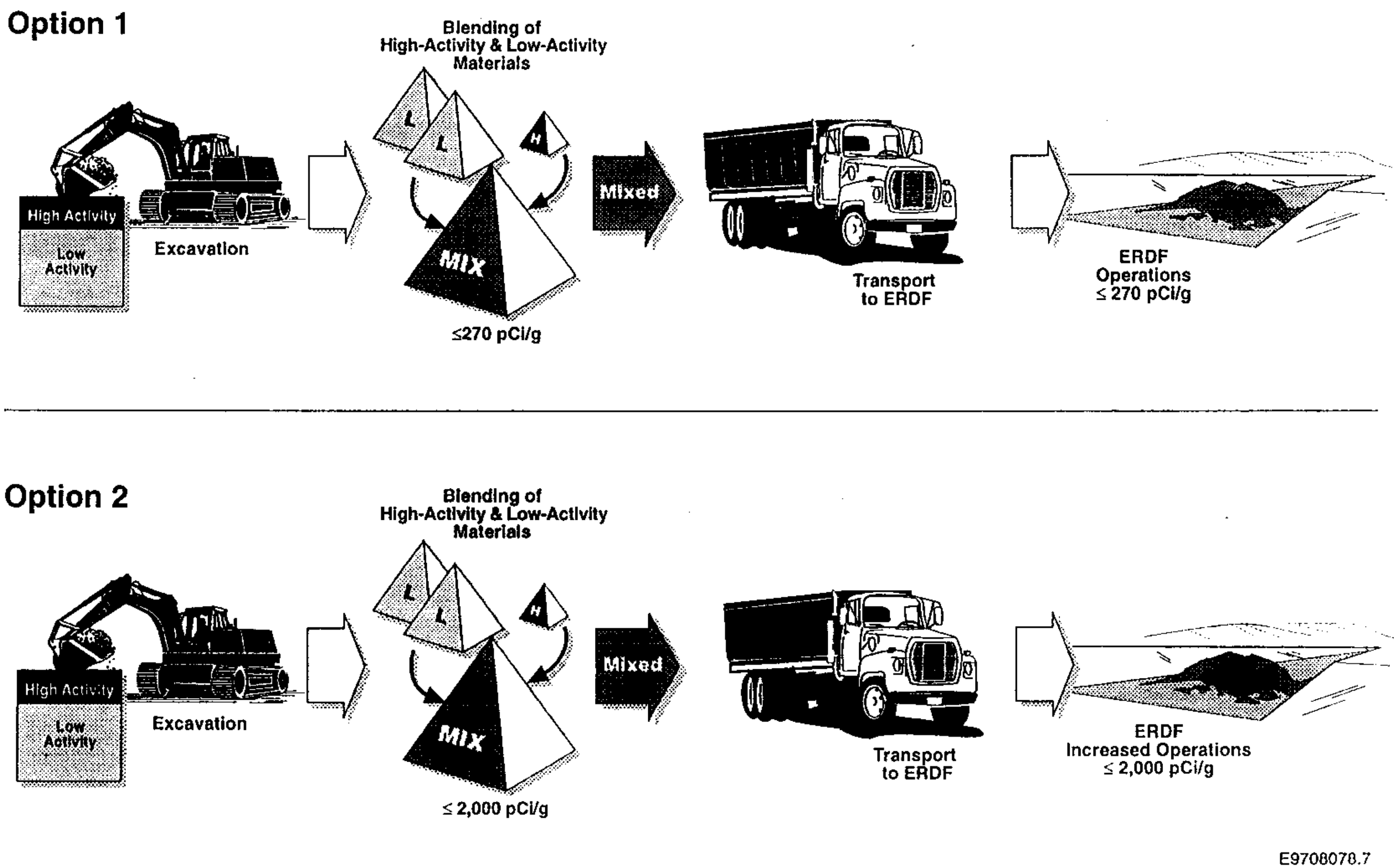


Figure 4-1. Remediation Options One and Two.

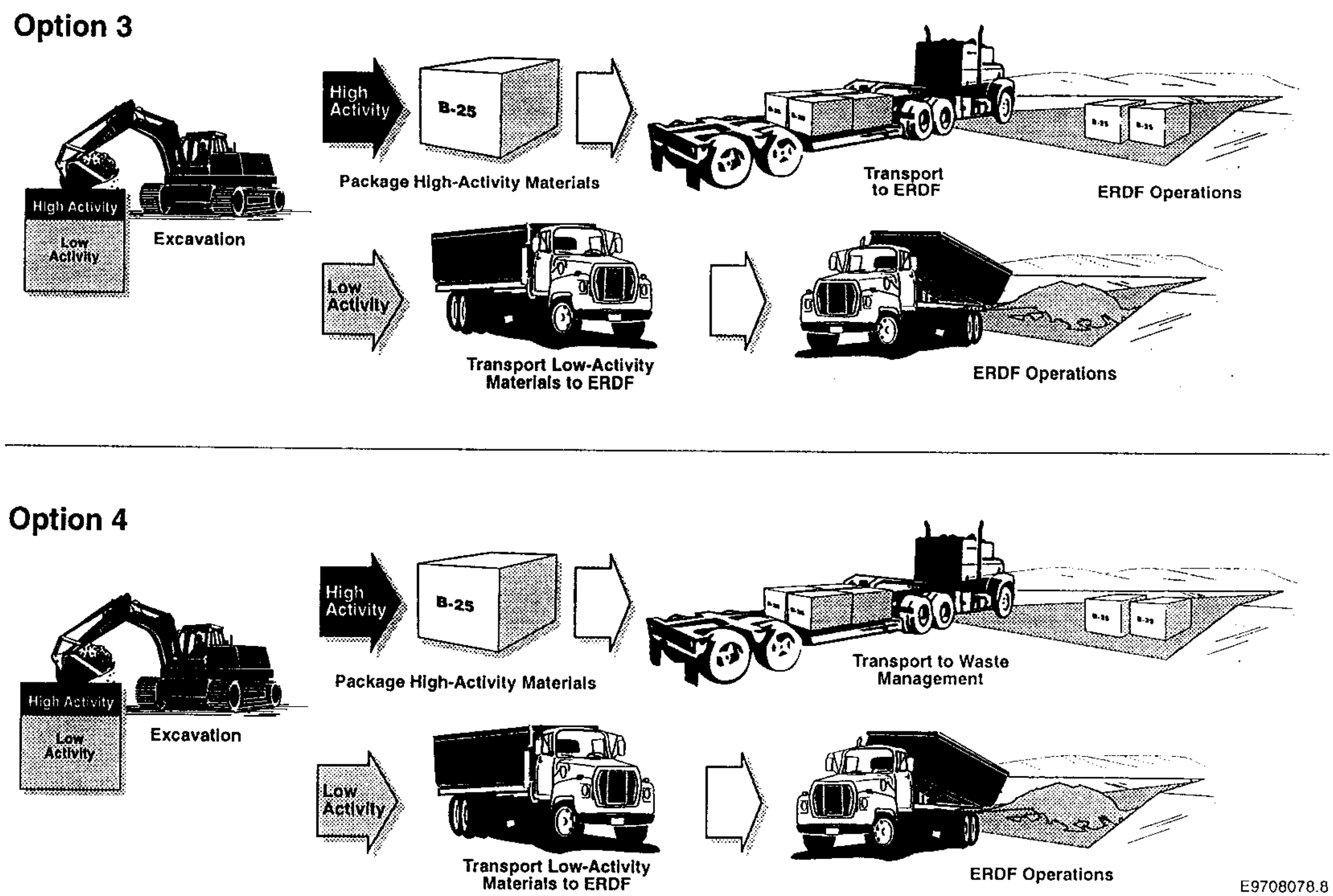


Figure 4-2. Remediation Options Three and Four.

Option 5

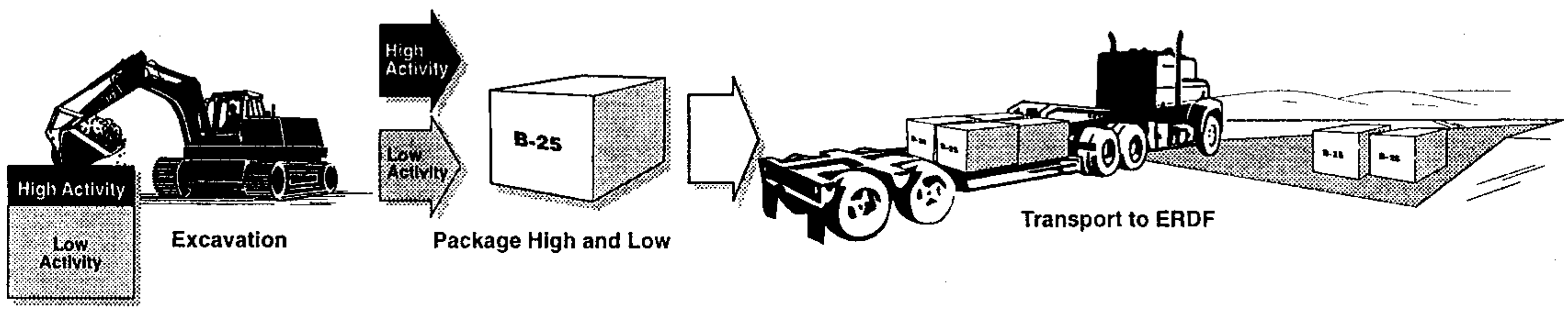


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Figure 4-3. Remediation Option Five.

Table 4-1. Volume of Waste for Disposal.

Waste Description	Volume in Cubic Yards				
	1301-N Crib	1301-N Trench	1325-N Crib	1325-N Trench	Total
High-Activity Waste	1,343	1,672	2,222	1,253	6,490
Low-Activity Waste	5,370	15,683	8,889	9,511	39,453
Total	6,713	17,355	11,111	10,764	45,453

Table 4-2. Final Mixed Volume of Each Waste Type to Meet Operational Limits.

Option Description	Waste Description	Volume in Cubic Yards				
		1301-N Crib	1301-N Trench	1325-N Crib	1325-N Trench	Total
Option 1: Current ERDF Operational Limit of 270 pCi/g (plutonium-239/240)	High-Activity Waste (188.2:1)	252,662	314,688	418,200	235,182	1,221,362
	Low-Activity Waste (8.7:1)	46,568	135,990	77,078	82,471	342,107
	Total	299,230	450,678	495,278	318,284	1,563,469
Option 2: Increased ERDF Operational Limit of 2,000 pCi/g (plutonium-239/240)	High-Activity Waste (25.4:1)	34,109	42,483	56,457	31,835	164,884
	Low-Activity Waste (1.2:1)	7,544	22,030	12,487	13,360	55,421
	Total	41,653	64,513	68,944	45,195	220,305
Options 3 and 4: Containerize High-Activity Material for Shipment	High-Activity Waste	1,343	1,672	2,222	1,253	6,490
	Low-Activity Waste (1.2:1)	7,544	22,030	12,487	13,360	55,421
	Total	8,887	23,702	14,709	14,613	61,911
Option 5 Containerize High- and Low-Activity Material	Total					45,943

Note: The values listed in Table 3-2 are approximate, based on rounding off from spreadsheet values.

5.0 ENGINEERING STUDY COST ESTIMATE AND DOSE EVALUATION

5.1 DESCRIPTION OF OPTIONS FOR DOSE EVALUATION

The following descriptions for dose evaluation applied standard time, distance, and shielding approaches for management of radiation dose to workers.

General assumptions and basic descriptions of activities listed in Appendix H of the CMS (DOE-RL 1996b) are valid for the mixing options. These basic assumptions are as follows:

- The exposure estimate can be obtained using MICRO SHIELD Version 4.2.
- Correction factors for dose called "build-up factors" were not used in the above model.
- The highest soil concentrations are found in the 1301-N Crib and Trench.
- The lower contaminated soils can be placed in the same container as highly contaminated soils to provide shielding.
- Previous sampling data provides adequate information to construct a conservative dose model of the cribs.
- No allowance was made for decay of radioactive materials during the remediation project.

Appendix C presents the dose calculation packages for the following options.

5.1.1 Option 1

Based on this option's failure to compare well to the criteria developed in Section 3.0, this option was not carried through for dose and cost evaluation.

5.1.2 Option 2

5.1.2.1 Excavation. The excavation operator uses equipment with a long boom so that he is rarely within 10 m (30.5 ft) of the excavation bucket or container.

The excavation operator is exposed to the unshielded soil for 3.25 hr/d at a distance of 10 m (30.5 ft), regardless of the materials that are being handled. Shielding will be added to the cab to ensure that the operator can spend standby time in an area that is less than 0.5 mrem/hr when not actively excavating.

High-activity boulders will be removed and placed in B-25 boxes. A forklift operator will be required to move the B-25 boxes. Based on the shielding and exposure assumptions, the average dose rate for the forklift was calculated to be 3.5 mrem/hr. Half of the work day will be spent handling empty containers and the other half handling full containers. The operator will be exposed to full containers for 3 hr/d.

The remaining soil will be placed in standard containers and mixed with less contaminated soil. Approximately 0.7 m^3 (0.9 yd^3) of highly contaminated soil will be placed in each container; the container will then be moved to a stockpile of low, contaminated soil where it is filled.

The excavation container handler is exposed to 0.7 m^3 (0.9 yd^3) of highly contaminated soil placed in the container for about 5 minutes between the excavation at the crib/trench and the stockpile. This soil is at least 3 m (9.15 ft) away from the driver. After the soil is added at the stockpile, the doses to the driver are near background levels.

The operator who fills the remainder of the container with less contaminated soil works in an area that is near natural background. This operator is never within 10 m (30.5 ft) of the unshielded soil. It takes 1 minute to place enough soil to lower the operator's exposure to near background levels. The exposure time is for 40 minutes a day.

Soil below the highly contaminated layer will be mixed with low contaminated soils immediately adjacent to them and shipped to ERDF in standard shipping containers. Soil exposure will be low. It is assumed that mixing to reach target plutonium concentrations will cause a corresponding decrease in the gamma-emitting isotope concentrations.

While the container is empty, the exposure is at background levels. There are two drivers; each driver is exposed to loads of contaminated soils for 3 hr/d.

5.1.2.2 Packaging. The B-25 boxes will be capped using a grout pump and boom so workers are not exposed during the capping process. This consolidates the void fill and capping operation while minimizing worker exposures.

The B-25 boxes are then placed on a truck by the forklift operator, surveyed, and shipped directly to ERDF. It is assumed that enough shielding will be in place such that the average dose rate is 3.5 mrem/hr for the driver. Doses for radiological control technicians (RCT) are accounted for as dose received during coverage of excavation work. Long poles and extended probes will be used in conjunction with shadow shielding to ensure RCTs are not exposed to more than 2 mrem/hr on average.

For the containers with mixed soil, survey and tarping techniques are identical to those currently used at other remediation sites. Exposure to RCTs who perform surveys, and laborers who seal the plastic liner and place tarps on the container will be similar as well.

5.1.2.3 Transportation. The B-25 boxes full of boulders are shipped directly to ERDF on shielded trucks. Exposure to the driver will be less than 3.5 mrem/hr. The driver will be exposed to full containers for 3 hr/d. Four drivers will support this operation.

Soils from the mixing process will be placed such that exposures to drivers will be very near exposures currently observed at other low-level sites. The unshielded doses to the drivers will average less than 0.5 mrem/hr. Drivers will be exposed to full containers for 4 hr/d. Four drivers will support this operation.

5.1.2.4 Disposal. The B-25 boxes full of boulders will be off-loaded directly into the ERDF waste with a crane. Rigging will be designed to minimize worker exposures during the off-load. It is assumed the workers will not be within 0.9 m (3 ft) of each box for more than 1 minute. The crane operator is always at least 9 m (27.5 ft) from the boxes. It is possible to off-load 100 boxes a day.

The highly contaminated soil is mixed to provide less than 7% of the total soil in each container. The less contaminated soil is mixed to comprise about 50% of each container. The containers from the 1301-N and 1325-N Crib and Trench remediation comprise one-third of the containers being handled at ERDF. Only a minor increase in exposures at ERDF will occur as a result of this option. This increase can be mitigated with some of the same operational controls that will be implemented to minimize the potential to generate airborne contamination. It is assumed that worker exposures are about 0.5 mrem/hr for 500 hr/yr as a result of this operation.

5.1.3 Option 3

5.1.3.1 Excavation. The need for offsite soils in the mixing operation is not required, and forklift operations are extended to include packaging the most highly contaminated layer of soil, as well as the boulders in B-25 boxes. This eliminates the need for a second trackhoe operator and consolidates both the site container and transportation drivers' roles for the most highly contaminated soils. Shielding is placed for the trackhoe operator and the driver, as discussed above.

The remaining soils are mixed with surrounding lower, contaminated soil and handled in standard shipping containers same fashion as described in Option 2 for soils that are mixed. All conditions are the same as those for the mixed soils in Option 2.

5.1.3.2 Packaging. The B-25 boxes are handled the same as in Option 2. The standard ERDF containers are filled and handled the same as the containers filled with soils from below the most highly contaminated layer in Option 2.

5.1.3.3 Transportation. Shielding is applied to all trucks that carry B-25 boxes. It is estimated that 50 boxes from 1301 N will also be placed at least 8 m (24.4 ft) from the driver's cab to ensure that dose rates in the cab are managed.

5.1.3.4 Disposal. The B-25 boxes and standard containers are handled as described in Option 2. Doses are higher because there is no shielding in the B-25 boxes. Overall exposure is lower because the duration of the task is shorter.

5.1.4 Option 4

The factors used for Option 3 for dose evaluation are the same for this option.

5.1.5 Option 5

All waste will be placed in B-25 boxes and sent to ERDF.

Dose rates calculated assume all boxes are filled at the average contamination level. Shielding will be used to maintain doses to less than 3.3 mrem/hr for drivers and workers in close proximity to the boxes.

The handling of B-25 boxes through all stages of the operation is the same as described in Option 2. Figure 5-1 represents results of dose evaluation for each remediation option.

5.2 DESCRIPTION OF OPTIONS FOR COST ESTIMATING

5.2.1 Cost Estimate Basis

The cost estimates presented reflect experience gained from ongoing remedial actions in the 100 and 300 Areas. In addition, where cost data were not available, best commercial practice was applied to further develop the cost estimate for each option. The cost for concrete and boulder removal will be the same for all options.

Table 5-1 summarizes each option for excavation, packaging, transportation, and disposal that was the basis for the cost estimate for each option. In addition, Appendix D presents the details included in each cost estimate for the remediation options. Costs not included for remedial action are pipeline removal and revegetation. Figure 5-2 presents the results of the cost estimate for each option.

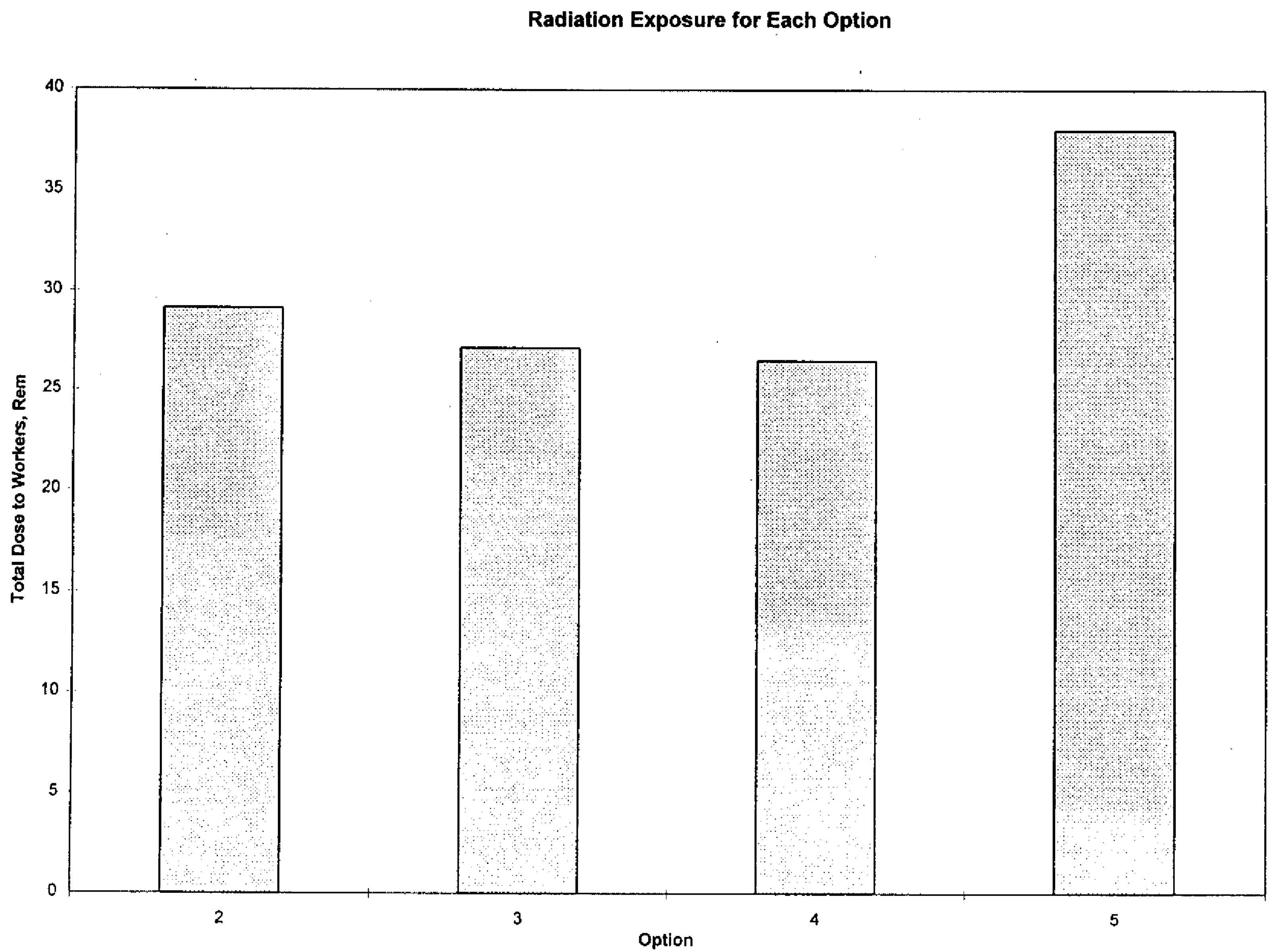
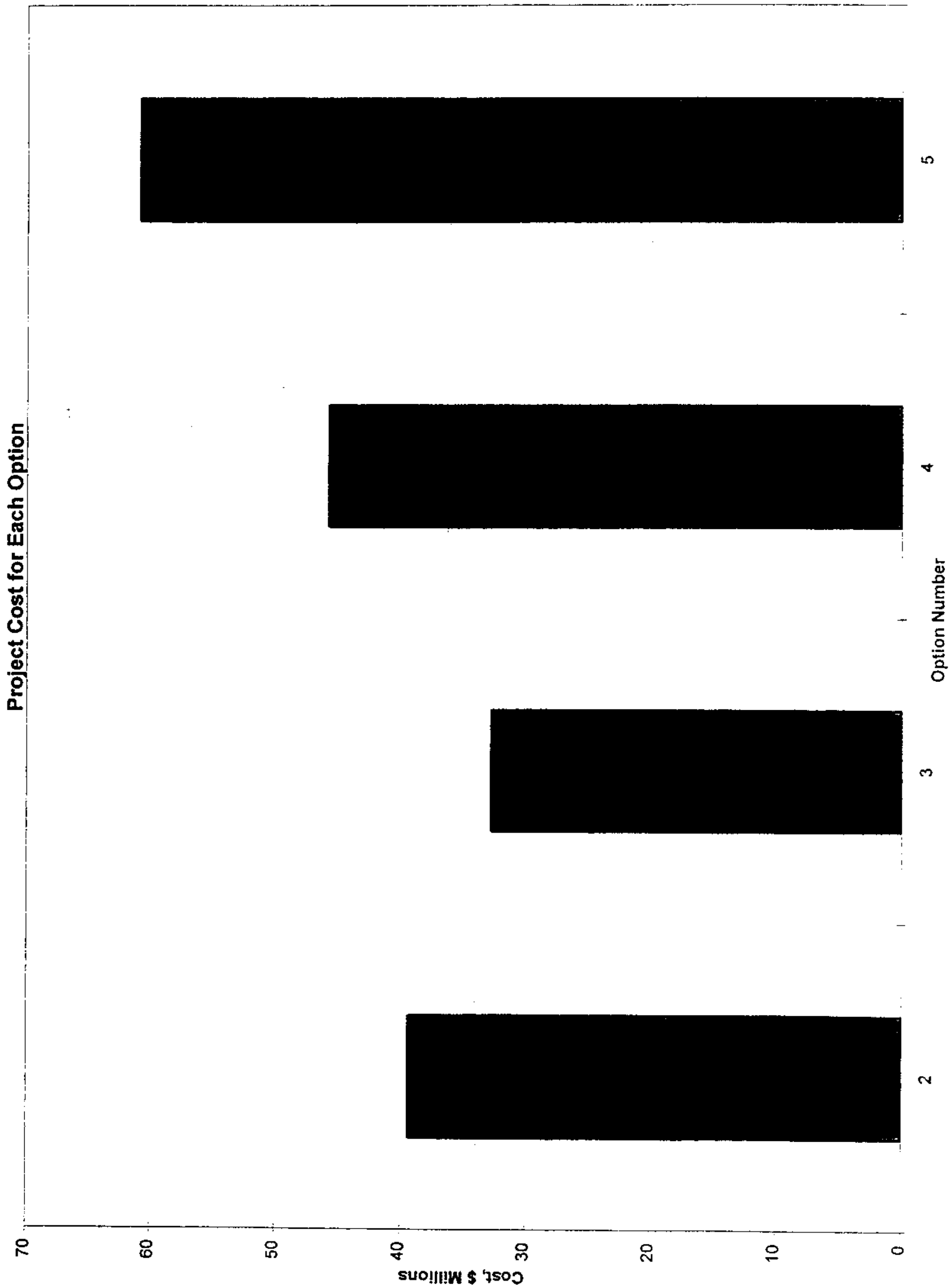


Figure 5-1. Results of Dose Evaluation for Each Remediation Option.

Figure 5-2. Results of Cost Estimate for Each Remediation Option.



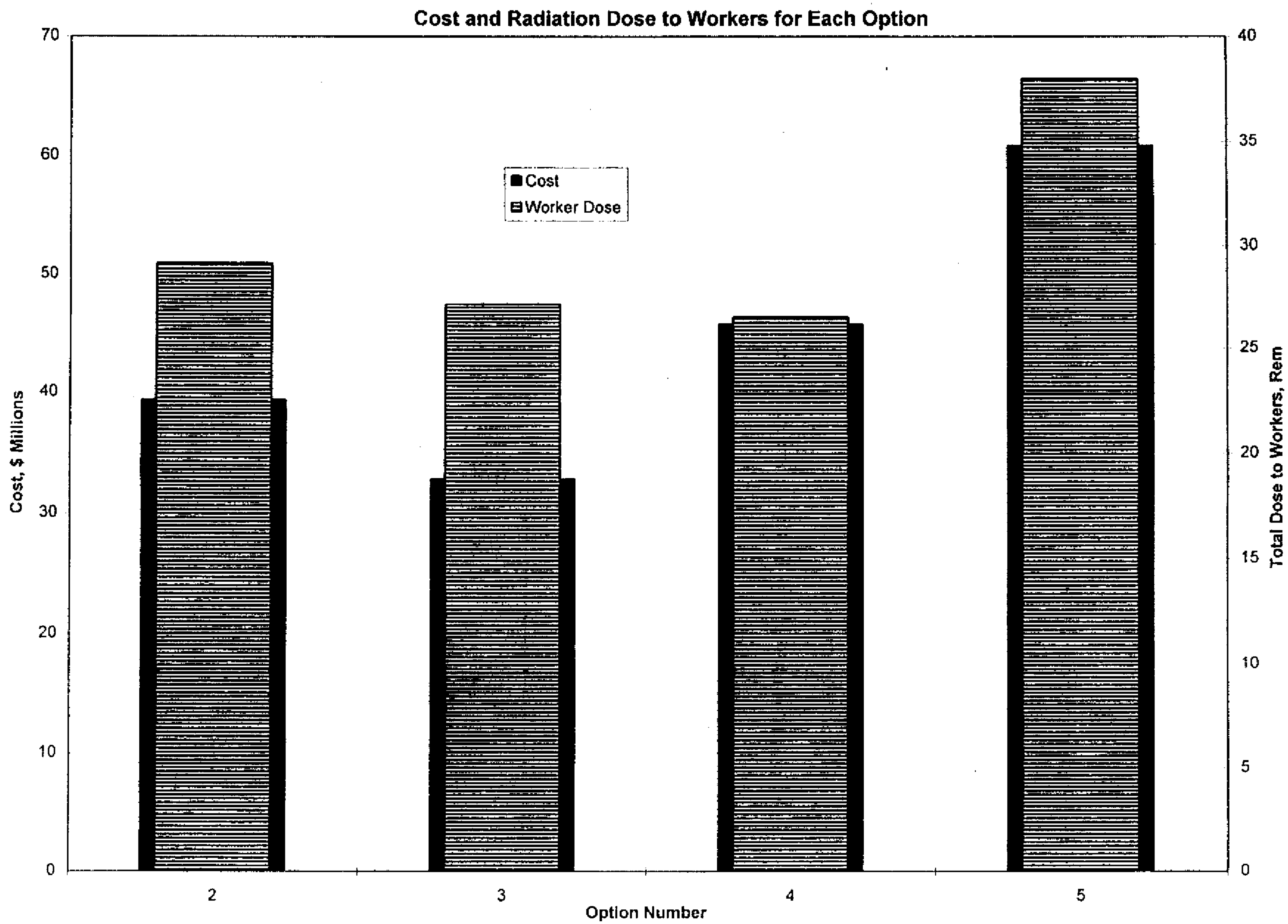


Figure 5-3. Results of Dose/Cost Estimates for Each Remediation Option.

Table 5-1. Remediation Option Summary.

	Excavation	Packaging	Transportation	Disposal
Option 1	• Blend to meet ERDF limits (high-activity zone 190.0:1.0/ low-activity zone 5.0:1.0)	• RCI containers	• RCI trucks	• Existing ERDF operations
Option 2	• Blend to meet ERDF modified limits (high-activity zone 21.0:1.0/ low-activity zone 1.2:1.0)	• RCI containers	• RCI trucks	• Modified ERDF operations (modified free dump operation)
Option 3	• Excavate and package high-activity zone • Blend low-activity zone 1.2:1.0	• B-25 boxes for high activity • RCI containers for low activity	• Flatbed for high activity in B-25 boxes • RCI trucks for low activity	• Modified ERDF operations (special handling for B-25 containers, use modified free dump operation for low activity)
Option 4	• Excavate and package high-activity zone • Blend low-activity zone 1.2:1.0	• B-25 containers for high activity (RUST criteria) • RCI containers for low activity	• Flatbed for high activity in B-25 boxes • RCI trucks for low activity	• B-25 containers to waste management • Use modified ERDF operation for low activity
Option 5	• Excavate and package high- and low-activity zone	• B-25 containers for all material	• Flatbed for all materials	• Send to ERDF for disposal

6.0 DESIGN/REMEDIAL ACTION ISSUES

During development of this study, the following issues surfaced, and although assumptions were made to continue with the study objectives, these issues were identified and require further investigation during the design phase.

- **Transuranic Waste**. The LFI results identified three areas in the 1301-N Trench and the 1325-N Crib as "hot spots" that have high levels of plutonium. Additional data are needed to address these hot spots to determine the presence of transuranic waste.

- **Contaminated Materials**. Confirmation of contamination types, extent, total volume of contaminated steel piping, and other structural materials associated with the cribs and trenches must be addressed during remedial design. Data were not available for any concrete or piping. However, based on available data within the crib/trench, assumptions were made for the level and extent of contamination for the concrete material for all of the 1301-N Crib, 1301-N Trench, 1325-N Crib, and one leg of the 1325-N Trench. The last three legs of the 1325-N Trench are believed to be clean based on operational data. Additional data on the concrete materials may provide a more accurate assessment of what will need to be sent to ERDF and what volume can be free released for other uses.

- **Contamination Levels**. This engineering study was based on data from the LFI. The projected contaminated volumes that would be generated during remediation were based on a limited amount of data consisting of surface samples of indeterminant quality and data from one borehole through the most contaminated area. Additional data are needed to confirm waste distribution and level of contamination in the zones to be excavated.

- **Container Requirements**. Safety analysis work will need to be performed to support the use of existing ERDF containers and for the use of B-25 boxes. Evaluation may need to be performed during the design to determine optimum use of existing containers or other containers that can support the remediation.

- **Dust Control**. Dust control measures and monitoring impacts to meet the 2,000 pCi/g (plutonium-239/240) soil concentration limit will need to be fully developed and specifically identified in the design and presented in the subcontract.

- **Subcontract Requirements for Radiological Controls**. Address how specific radiological requirements will be addressed in the subcontract (i.e., three shifts to support high-activity material during remediation).

- **ERDF Operations**. ERDF operational requirements to coordinate and schedule the processing of the containers of highly contaminated material from the cribs and trenches should be addressed during the planning and design phase for this remediation. Additional controls for the increased radiological limits must also be fully developed and specified.

7.0 ENGINEERING STUDY CONCLUSIONS

The following conclusions were derived based on the results of this engineering study:

- **Preferred Option**. Option 3 is the preferred remediation option for the 1301-N and 1325-N Cribs and Trenches. Option 3 is selected based on cost and total dose to workers. This option is comprised of packaging the high-activity material in B-25 boxes for shipment to ERDF for disposal. The lower activity material will be shielded with overburden and other contaminated soils encountered during excavation operations. Soil used for shielding will be blended with the lower activity soil to meet a 1.2:1.0 ratio to meet the ERDF soil concentration limit of 2,000 pCi/g (plutonium-239/240).

- **Implementability**. Based on the available data from the LFI, draft CMS, cost estimate, and dose evaluation, this study concluded that the selected option is implementable.

- **Impacts to ERDF**. Existing ERDF operations data confirmed that it would be possible to operate ERDF with a requirement to maintain dust loads of less than 50 $\mu g/cm^2$. This requirement would permit the use of a limit of 2,000 pCi/g, as used in the study.

- **Higher Cost for Remediation**. Higher remediation costs were calculated than presented in the draft CMS. These higher costs were based on increased focus on ERDF requirements. Based on these requirements and increased volumes for mixing, the use of containers (B-25 boxes) was identified, which increased the estimated cost by approximately $15 million.

- **Impacts of Delaying Remediation to Allow for Additional Radioactive Decay**. The majority of worker exposure will result from gamma radiation emitted by cobalt-60 and cesium-137. By the year 2001, cesium-137 will be the dominant gamma emitter. Because cesium-137 has a half-life of about 30 years, delaying the work near term will only have a minimal impact on exposure rates. The exposure rates relate directly to the amount of overburden used as shielding, which affects waste volumes and costs. Therefore, the study did not identify significant cost benefits to any option that would result from permitting additional radioactive decay of the waste to occur near term.

8.0 REFERENCES

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Oztunali, O. I., et al., 1981, *Data Base for Radioactive Waste Management, Impacts Analyses, Methodology Report*, NUREG/CR-1759, Vol. 3, prepared by Dames and Moore, White Plains, N.Y., for Office of Nuclear Material Safety and Safeguards, U.S. Nuclear Regulatory Commission, Washington, D.C.

APPENDIX A

LIMITED FIELD INVESTIGATION RESULTS

Table A-1. Radionuclide Concentrations Detected in 1301-N Trench Sediment from 1980 to 1985 from Locations TS-01 to TS-09 Decayed to January 1, 2001. (Page 1 of 2)

Location: Units:	TS-01 pCi/g	TS-02 pCi/g	TS-03 pCi/g	TS-04 pCi/g	TS-05 pCi/g	TS-06 pCi/g	TS-07 pCi/g	TS-08 pCi/g	TS-09 pCi/g
Collection Date:					1980				
Gross alpha	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gross beta	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cerium-144	0.0831	0.0310	0.0083	0.0060	0.0039	0.0065	0.0031	ND	0.0025
Cesium-134	NA	NA	NA	NA	36	NA	NA	NA	NA
Cesium-137	166,669	129,631	74,075	135,804	160,496	129,631	148,150	388,894	216,052
Cobalt-58	0	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt-60	821,354	555,994	530,721	322,224	195,861	353,814	107,408	480,176	271,679
Europium-154	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron-59	NA	0	NA	NA	NA	NA	NA	NA	NA
Manganese-54	0.180	0.115	0.057	0.041	0.025	0.045	0.014	0.018	0.029
Niobium-95	0	0	0	0	0	0	0	ND	0
Plutonium-238	NA	NA	NA	NA	NA	NA	NA	NA	NA
Plutonium-239/240	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ruthenium-103	NA	0	NA	NA	NA	NA	NA	NA	NA
Ruthenium-106			NA	NA	NA	NA	NA	NA	NA
Strontium-90	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zirconium-95	0	0	NA	NA	NA	NA	NA	NA	NA
Collection Date:					1981				
Gross alpha	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gross beta	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cerium-144	0	0	NR	0	0	0	0	0	0
Cesium-134	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cesium-137	120,016	120,016	334,782	208,449	309,516	360,049	334,782	277,932	492,698
Cobalt-58	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt-60	475,727	454,103	1,369,517	432,479	317,151	1,225,357	641,510	389,231	598,263
Europium-154	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron-59	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese-54	0.1198	0.1014	0.1567	0.0903	0.0359	0.1198	0.0830	0.0691	0.0913
Niobium-95	0	0	NA	NA	NA	NA	NA	NA	NA
Plutonium-238	4,697	1,281	5,295	1,537	666	4,184	5,380	1,025	3,416
Plutonium-239/240	25,945	9,181	24,947	11,975	5,488	24,947	29,937	6,586	19,958
Ruthenium-103	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ruthenium-106		NA	NA	NA	NA	NA	NA	NA	NA
Strontium-90	105,062	475,868	67,981	22,248	12,978	59,329	67,981	15,450	27,810
Zirconium-95	NA	NA	NA	NA	NA	NA	NA	NA	NA
Collection Date:					1982				
Gross alpha	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gross beta	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cerium-144	NA	0.0943	NA	NA	NA	NA	NA	NA	0.0584
Cesium-134	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cesium-137	607,552	316,702	607,552	342,556	349,019	323,166	646,332	297,313	361,946
Cobalt-58	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt-60	1,726,248	2,219,462	2,794,878	526,095	542,535	1,233,035	1,150,832	369,910	353,470
Europium-154	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron-59	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese-54	0.1470	0.3935	0.1781	0.0953	0.0953	0.0973	0.1015	0.0559	ND
Niobium-95	NA	NA	NA	NA	NA	NA	NA	NA	NA
Plutonium-238	4,734	12,050	24,961	438,974	103,288	8,005	3,271	8,177	947
Plutonium-239/240	27,944	62,874	169,660	2,794,394	658,679	43,912	16,966	15,968	12,974
Ruthenium-103	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ruthenium-106	NA	NA	NA	NA	NA	NA	NA	NA	NA
Strontium-90	69,636	158,263	202,576	94,958	69,636	145,602	52,543	44,314	94,958
Zirconium-95	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table A-1. Radionuclide Concentrations Detected in 1301-N Trench Sediment from 1980 to 1985 from Locations TS-01 to TS-09 Decayed to January 1, 2001. (Page 2 of 2)

Location:	TS-01	TS-02	TS-03	TS-04	TS-05	TS-06	TS-07	TS-08	TS-09
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Collection Date:	1983								
Gross alpha	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gross beta	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cerium-144	NA	NA	NA	0.0415	NA	NA	NA	NA	NA
Cesium-134	ND	ND	ND	ND	67	ND	88	67	NA
Cesium-137	54,891,147	363,737	383,577	251,309	476,164	628,272	529,071	264,536	257,922
Cobalt-58	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt-60	2,062,419	1,499,941	2,343,658	749,971	487,481	1,499,941	562,478	374,985	374,985
Europium-154	31,498	ND	ND	13,084	19,383	41,190	ND	ND	ND
Iron-59	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese-54	0.284	0.191	0.288	0.437	0.060	0.140	0.065	0.079	0.102
Niobium-95	NA	NA	NA	0	NA	NA	NA	NA	NA
Plutonium-238	2,082	2,603	1,562	1,301	486	1,735	954	720	798
Plutonium-239/240	11,977	12,975	9,981	7,486	2,994	9,781	6,188	4,591	4,292
Ruthenium-103	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ruthenium-106	NA	NA	NA	NA	NA	NA	NA	NA	NA
Strontium-90	29,829	29,829	18,805	16,860	8,430	29,829	17,508	8,430	5,642
Zirconium-95	NA	NA	NA	NA	NA	NA	NA	NA	NA
Collection Date:	1984								
Gross alpha	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gross beta	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cerium-144	NA	NA	NA	NA	NA	NA	0	NA	NA
Cesium-134	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cesium-137	2,097,755	649,627	554,890	507,521	879,704	507,521	663,161	493,987	879,704
Cobalt-58	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt-60	5,666,310	2,352,053	3,421,168	1,710,584	887,365	2,458,965	1,710,584	1,710,584	1,603,673
Europium-154	NA	NA	NA	NA	39,320	NA	NA	NA	NA
Iron-59	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese-54	0.826 U	0.491	0.544	1.359	0.199 U	0.366	3.345	0.784	1.150
Niobium-95	NA	NA	NA	NA	NA	NA	NA	NA	NA
Plutonium-238	NA	NA	NA	NA	NA	NA	NA	NA	NA
Plutonium-239/240	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ruthenium-103	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ruthenium-106	NA	NA	NA	NA	NA	NA	NA	NA	NA
Strontium-90	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zirconium-95	NA	NA	NA	NA	NA	NA	NA	NA	NA
Collection Date:	1985								
Gross alpha	35,000	28,000	52,000	38,000	34,000	42,000	19,000	18,000	28,000
Gross beta	1,900,000	19,000,000	13,000,000	6,500,000	5,000,000	10,000,000	6,000,000	2,800,000	2,300,000
Cerium-144	0.0565 U	0.0435 U	0.0546 U	0.0552 U	0.0448 U	0.0513 U	0.0325	0.0071 U	0.0409 U
Cesium-134	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cesium-137	20,081	18,004	25,621	19,389	38,085	47,087	38,777	15,234	17,311
Cobalt-58	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt-60	158,560	134,166	195,151	146,363	115,871	134,166	158,560	31,712	78,060
Europium-154	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron-59	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese-54	0.1271	0.0400	0.0541 U	0.2353	0.1318	0.0424 U	0.3530	0.0659	0.0941
Niobium-95	NA	NA	NA	NA	NA	NA	NA	NA	NA
Plutonium-238	4,054	2,556	4,495	3,525	3,437	3,702	2,027	1,586	2,997
Plutonium-239/240	25,956	15,973	26,954	22,961	20,965	23,960	13,976	10,981	19,966
Ruthenium-103	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ruthenium-106	NA	NA	NA	NA	NA	NA	NA	NA	NA
Strontium-90	63,282	52,395	142,895	74,850	129,286	81,654	81,654	47,632	74,850
Zirconium-95	NA	NA	NA	NA	NA	NA	NA	NA	NA

U = Concentration was undetected at specified detection level.
NA = Not analyzed
ND = Not detected; no detection limit given
NR = Not reported
Trench sediment samples collected by attaching a jar to a pole and using this device as a scoop. The top six inches of trench sediments were sampled through standing water.

References:

UNI-1581 = Radiological Surveillance Report for the 100-N Area-FY 1980
UNI-1849 = UNC Environmental Surveillance Report for 100 Areas-FY 1981
UNI-2226 = UNC Environmental Surveillance Report for 100 Areas-FY 1982
UNI-2640 = UNC Environmental Surveillance Report for 100 Areas-FY 1983
UNI-3069 = UNC Environmental Surveillance Report for 100 Areas-FY 1984
UNI-3760 = UNC Environmental Surveillance Report for 100 Areas-FY 1985

Table A-2. Radionuclide Concentrations Detected in 1325-N Crib Sediments from 1985 to 1987 from Locations CS-01 to CS-12 Decayed to January 1, 2001.

Location:	CS-01	CS-02	CS-03	CS-04	CS-05	CS-06	CS-07	CS-08	CS-09	CS-10	CS-11	CS-12
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Collection Date:	1985											
Gross alpha	18,000	7,000	18,000	6,000	4,700	NR	44,000	26,000	18,000	12,000	9,700	6,100
Gross beta	2,300,000	3,100,000	1,600,000	830,000	400,000	NR	15,000,000	2,400,000	2,200,000	1,100,000	1,500,000	620,000
Cerium-144	0.078	0	0	0	0	NR	0 U	0	0	0	0	0
Cesium-137	28,391	4,815	4,815	3,440	1,278	NR	1,081	2,850	491	5,503	4,717	6,977
Cobalt-60	158,560	1.13	1.88	1.02	0.31	NR	2.73	2.90	0.24	0.89	1.36	0.99
Manganese-54	0.64	0	0	0	0	NR	0	0	0	0	0	0
Plutonium-238	1,763	333	901	297	207	NR	2,253	3,875	811	158	496	239
Plutonium-239/240	11,980	4,947	12,862	4,254	2,770	NR	29,682	55,407	11,873	2,276	6,827	33,640
Strontium-90	59,880	2,288	7,832	2,376	1,320	NR	17,601	8,800	1,496	1,144	1,056	510
Collection Date:	1986											
Gross alpha	NR	NR	NA	NA	NA	NR	NR	NA	NA	NR	NR	NR
Gross beta	NR	NR	NA	NA	NA	NR	NR	NA	NA	NR	NR	NR
Cerium-144	1.218	0.000	0.000	0.000	0.000	NR	NR	0	0	NR	NR	NR
Cesium-137	127,535	6,093	8,648	8,353	9,041	NR	NR	6,486	7,862	NR	NR	NR
Cobalt-60	1,265,793	0.887	3.923	4.264	1.057	NR	NR	2.899	4.775	NR	NR	NR
Manganese-54	8.46	0	0	0	0	NR	NR	0	0	NR	NR	NR
Plutonium-238	NA	NA	NA	NA	NA	NR	NR	NA	NA	NR	NR	NR
Plutonium-239/240	NA	NA	NA	NA	NA	NR	NR	NA	NA	NR	NR	NR
Strontium-90	6,343	343	440	440	299	NR	NR	NR	810	NR	NR	NR
Collection Date:	1987											
Gross alpha	NA	NA	NA	NA	NA	NR	NA	NA	NA	NA	NA	NA
Gross beta	NA	NA	NA	NA	NA	NR	NA	NA	NA	NA	NA	NA
Cerium-144	0.231 U	0.000 U	0.000 U	0.000 U	0.000 U	NR	0.000 U	0.000 U	0.000 U	0.000 U	0.000 U	0.000 U
Cesium-137	23,199	1,671 U	1,769	2,850	2,948	NR	4,717	1,474	1,671	2,064	1,278	1,278
Cobalt-60	130,078	2.388	1.074	1.074	1.160	NR	2.217	1.876	1.398	0.239	1.433	2.047
Manganese-54	1.544	0	0	0	0	NR	0	0	0	0	0	0
Plutonium-238	985	3,019	113	631	586	NR	7,660	9,462	586	1,036	1,397	2,704
Plutonium-239/240	5,192	48,481	1,583	9,795	8,410	NR	96,961	118,728	8,212	1,385	19,788	38,587
Strontium-90	9,996	3,520	519	378	880	NR	55,443	23,761	880	1,232	2,552	3,080

U = Concentration was undetected at specified detection level
NR = Not reported
NA = Not analyzed

References: UNI-3760 = UNC Environmental Surveillance Report for the 100 Areas - FY 1985
UNI-4065 = UNC Environmental Surveillance Report for the100 Areas - FY 1986
WHC-EP-0161 = Westinghouse Hanford Co. Environmental Surveillance Annual Report-100 Areas-FY 1987

Samples of surface sediment were collected from the bottom of the 1325-N Crib. Approximately 10 grams of sediment per sample were collected through the sample port located in the cover of the facility. The samples were collected during operations through standing water.

Table A-3. Concentrations Detected in Soil from Boreholes Located Near 1301-N/1325-N Decayed to January 1, 2001. (Page 1 of 5)

Reference Document:	222-S	222-S	222-S	222-S	222-S	222-S	222-S	222-S	222-S	222-S	Quanterra
Location:	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-107A
Sample ID:	B0GGC3*	B0GLF4	B0GLF5	B0GLF7	B0GLF6	B0GLF8 (Dup)	B0GLF9	B0GLG0	B0GLG1	B0H1V6	B0GL88
Method:											
Sample Collected:	8/25/95	11/29/95	11/30/95	12/5/95	12/5/95	12/5/95	12/6/95	12/6/95	12/8/95	12/8/95	11/29/95
Depth (feet below ground surface):	N/A	9-11	11-13	23	28-30	28-30	40	50	57-59	69	9.0-11.0
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	13,900	941	38,200	2.52 U	2.18 U	3.39 U	1.44 U	0.968 U	1.96 U	2.77	1,980
Gross beta	305,000	63,700	69,600	4,310	2,810	2,490	1,680	145	124	123	128,000
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Americium 241	17,152	849	1,121	NR	NR	NR	NR	NR	NR	NR	1,101
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium-109	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Carbon 14	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Cerium-144	NR	4.89 U	4.32 U	0.122 U	0.0708 U		0.0274 U	0.0128 U	0.0268 U	0.0269 U	-1.40 U
Cesium 134	NR	17.7 U	15.9 U	0.475	0.0513 U	0.0410 U	0.0177 U	0.0138 U	0.0263 U	0.0294 U	5.63 U
Cesium 137	90,194	10,764	13,434	2,483	5.17	5.06	0.127 U	NR	0.365 U	0.375 U	14,056
Chromium 51	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Cobalt 60	27,840	54,772	67,594	12.3	2.99	2.69	0.616	0.403	0.591	0.364	71,153
Cobalt-58	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-1.48E-06 U
Europium 152	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.20 U
Europium 154	7,740	690	918	0.656 U	0.373 U	0.380 U	0.192 U	0.197 U	0.352 U	0.329 U	663
Europium-155	1,950	174	149	2.73 U	0.989 U	0.910 U	0.352 U	0.163 U	0.346 U	0.343 U	102
Iron 59	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0 U
Lead-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Manganese-54	NR	2.26 U	2.06 U	0.00931 U	0.00434 U	0.00423 U	0.00159 U	0.00172 U	0.00397 U	0.302 U	0.918 U
Plutonium - 238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	217
Plutonium 239/240	12,693	NR	689	NR	NR	NR	NR	NR	NR	NR	1,589
Potassium 40	NR	422 U	457 U	0.110	7.02 U		11.6	2.05	16.9	17.0	879
Radium 226	NR	1,407 U	1,257 U	44.4 U	6.76 U	9.26 U	3.35 U	2.07 U	4.93 U	4.52 U	
Radium-224DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Radium-226DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	104 U
Radium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Radium-228DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Ruthenium 106	NR	U	U	U	U	U	U	U	U	U	U
Ruthenium-103	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Strontium 90	81,140	2,875	11,148	1,635	1,372	1,195	956	166	55.9	48.3	8,457
Technetium 99	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Thorium 228	NR	823 U	726 U	23.9	8.51 U	7.91	3.13 U	1.39 U	3.24 U	2.87 U	5.54 U
Thorium 232	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	62.2 U
Tin-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Uranium 233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	
Uranium 235	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.677 U
Uranium 238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-0.226 U
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	10.5 U
Zinc 65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	

* Sample scraped from a large boulder.

Table A-3. Concentrations Detected in Soil from Boreholes Located Near 1301-N/1325-N Decayed to January 1, 2001. (Page 2 of 5)

Reference Document:	Quanterra	Quanterra	Quanterra	Quanterra	Quanterra	222-S	222-S	222-S	222-S	222-S	222-S
Location:	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-108A	199-N-108A	199-N-108A	199-N-108A	199-N-108A	199-N-108A
Sample ID:	B0GL89	B0GL91	B0GL92 (Dup)	B0GL95	B0GL94 (EB)	B0GLD2	B0GLD5	B0GLD3	B0GLD4 (Dup)	B0GLD6	B0GLD7
Method:											
Sample Collected:	11/30/95	12/5/95	12/5/95	12/8/95	12/8/95	11/9/95	11/9/95	11/10/95	11/10/95	11/10/95	11/10/95
Depth (feet below ground surface):	11.0-13.0	28-30	28.30	57-59	N/A	14.5-16.5	18	23-25	23-25	28	32.5
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	2,530	7.43	6.43 U	6.61	3.62 U	1.4	51.1	1.33 U	1.45 U	1.31 U	1.38 U
Gross beta	131,000	4,480	5,120	293	2.88	2,280	17,600	2,690	2,770	435	228
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Americium 241	1,041	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium-109	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Carbon 14	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	0.677 U	-0.0062 U	0.0011 U	-0.0004 U	-0.0011 U	0.682 U	1.09 U	0.225 U	0.159 U	0.123 U	0.0706 U
Cesium 134	0.877 U	-0.0018 U	-0.0084 U	-0.0032 U	-0.0013 U	0.985 U	3.04	0.267 U	0.235 U	0.171 U	0.111 U
Cesium 137	11,121	2.19	5.35	0.0128 U	0.0103 U	2,843	13,949	96.0	75.4	21.4	1.19 U
Chromium 51	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt 60	61,449	2.54	2.86	0.66	-0.00218 U	265	1,677	5.29	7.22	1.79	0.508 U
Cobalt-58	-1.24E-06 U	5.00E-10 U	-1.0E-10 U	1.56E-10	-7.439E-10 U	NR	NR	NR	NR	NR	NR
Europium 152	55.3 U	0.0723 U	-0.160 U	0.0263 U	0.0350 U	NR	NR	NR	NR	NR	NR
Europium 154	541	0.104 U	0.0986 U	0.00892 U	-0.00114 U	6.03 U	12.2 U	2.66 U	2.43 U	1.47 U	1.07 U
Europium-155	69.2	0.0103 U	0.0654 U	0.00655 U	0.0177 U	7.84 U	11.7 U	2.97 U	2.05 U	1.55 U	0.809 U
Iron 59	0 U	0.00 U	0.00 U	0.00 U	0.00000 U	NR	NR	NR	NR	NR	NR
Lead-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Manganese-54	0.313 U	0.00161 U	0.000770 U	0.000589 U	-0.0001913 U	0.0781 U	0.147 U	0.0209 U	0.0152 U	0.0146 U	0.00916 U
Plutonium - 238	447	-0.00121 U	0.00791 U	0.00326 U	-0.0007898 U	NR	10.8	NR	NR	NR	NR
Plutonium 239/240	3,338	0.02299 U	0.0708	-0.00156 U	0.00472 U	NR	73.7	NR	NR	NR	NR
Potassium 40	55.4	9.33	9.93	15.7	0.488	43.1 U	43.3 U	48.4 U	13.0 U	35.4 U	15.7 U
Radium 226	NR	NR	NR	NR	NR	121 U	200 U	36.0 U	27.0 U	20.8 U	11.7 U
Radium-224DA	NR	NR	2E-153 U	3E-153	5.29E-154	NR	NR	NR	NR	NR	NR
Radium-226DA	24.9 U	0.345 J	0.368 J	0.364 J	0.189 J	NR	NR	NR	NR	NR	NR
Radium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228DA	NR	NR	NR		NR	NR	NR	NR	NR	NR	NR
Ruthenium 106	U	U	U	U	U	U	U	U	U	U	U
Ruthenium-103	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium 90	17,429	1,354	1,159	44.3	0.0682 U	123	694	1,246	1,219	172	105
Technetium 99	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 228	22.5 U	0.0738	0.0631	0.0728	0.0282	65.3 U	99.6 U	25.3 U	17.6 U	12.4 U	7.92 U
Thorium 232	-156 U	1.08	0.388 U	0.624	NR	NR	NR	NR	NR	NR	NR
Tin-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 235	-0.672 U	0.0227 U	0.00386 U	0.0193 U	-0.00388 U	NR	NR	NR	NR	NR	NR
Uranium 238	9.99 U	0.363	0.441	0.364	0.0127 U	NR	NR	NR	NR	NR	NR
Uranium-234	5.12 U	0.414	0.479	0.302	0.0347	NR	NR	NR	NR	NR	NR
Zinc 65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A-3. Concentrations Detected in Soil from Boreholes Located Near 1301-N/1325-N Decayed to January 1, 2001. (Page 3 of 5)

Reference Document:	222-S	222-S	222-S	222-S	222-S	222-S	Quanterra	Quanterra	Quanterra	Quanterra	Quanterra
Location:	199-N-108A	199-N-108A	199-N-108A	199-N-108A	199-N-108A	199-N-108A	199-N-108A	199-N-108A	199-N-108A	199-N-108A	199-N-108A
Sample ID:	B0GLD8	B0GLD9	B0GLF0	B0GLF1	B0GLF2	B0GLF3	B0GL71	B0GL73	B0GL75 (Dup)	B0GL81	B0GL86
Method:											
Sample Collected:	11/15/95	11/15/95	11/15/95	11/15/95	11/16/95	11/16/95	11/9/95	11/10/95	11/10/95	11/15/95	11/16/95
Depth (feet below ground surface):	42-44	47	52	59.5	62-63.5	69	14.5-16.5	23-25	23-25	42-44	62-63.5
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	1.02 U	1.86 U	2.46 U	1.53 U	**1.65**	1.47 U	**30.1**	**7.69**	**7.60**	**9.33**	2.9 U
Gross beta	**80.9**	**34.8**	**20.0**	**537**	**272**	**74**	**5,750**	**3,790**	**2,740**	**132**	**328**
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Americium 241	NR	NR	NR	NR	NR	NR	**6.50**	NR	NR	NR	NR
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium-109	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Carbon 14	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	0.0770 U	0.0967 U	0.105 U	0.115 U	0.0881 U	-0.0004 U	-0.0065 U	0.0017 U	0.0027 U	-0.0006 U	-0.0009 U
Cesium 134	0.0958 U	0.144 U	0.123 U	0.153 U	0.148 U	0.0828 U	**0.939**	-0.0103 U	-0.0045 U	0.0042 U	-0.0066 U
Cesium 137	1.54 U	2.02 U	1.511 U	2.24 U	1.83 U	1.65 U	**6,015**	**39.4**	**58.5**	0.00626 U	-0.0182 U
Chromium 51	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt 60	0.424 U	0.497 U	0.698 U	0.901 U	0.501 U	0.308 U	**610**	**3.61**	**4.68**	**0.279**	**0.273**
Cobalt-58	NR	NR	NR	NR	NR	NR	0.00 U	-3E-11 U	-1E-10 U	5E-10 U	2E-10 U
Europium 152	NR	NR	NR	NR	NR	NR	0.641 U	0.00721 U	0.0486 U	-0.0525 U	-0.00641 U
Europium 154	1.50 U	2.08 U	2.51 U	2.50 U	1.28 U	1.61 U	**5.45**	0.119 U	**0.155**	0.0654 U	-0.0150 U
Europium-155	0.967 U	1.04 U	1.309 U	1.28 U	1.08 U	0.879 U	**1.15**	0.00634 U	0.0546 U	-0.00394 U	0.0532 U
Iron 59	NR	NR	NR	NR	NR	NR	6E-14 U	-3.442E-14 U	2.076E-14 U	-6.41E-14 U	1.058E-14 U
Lead-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Manganese-54	0.00923 U	0.0152 U	0.0155 U	0.0137 U	0.0113 U	0.0120 U	**0.014**	0.000876 U	0.000764 U	-0.000281 U	-0.000127 U
Plutonium - 238	NR	NR	NR	NR	NR	NR	1.12 U	0.10082 U	0.0828 U	-0.00361 U	U
Plutonium 239/240	NR	NR	NR	NR	NR	NR	**12.6**	0.0210886 U	0.3008367 U	-0.003758 U	-0.0041578 U
Potassium 40	27.1 U	35.2 U	12.6 U	25.1 U	16.6 U	30.0 U	**13.7 J**	**18.1 J**	**15.8 J**	**10.9 J**	**18.6**
Radium 226	12.9 U	16.2 U	21.8 U	20.3 U	14.7 U	14.1 U	1.54 U	**0.598 J**	**0.806 J**	**0.499 J**	**0.523 J**
Radium-224DA	NR	NR	NR	NR	NR	NR	NR	**2E-155**	**3E-155**	**4E-155**	**4E-155**
Radium-226DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228DA	NR	NR	NR	NR	NR	NR	NR	NR			NR
Ruthenium 106	U	U	U	U	U	U	U	U	U	U	U
Ruthenium-103	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium 90	**21.7**	**3.83**	**1.22**	**211**	**21.8**	**114**	**679**	**1,264**	**1,537**	**51.2**	**127**
Technetium 99	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 228	7.53 U	9.77 U	11.6 U	11.5 U	9.51 U	7.76 U	0.114 U	**0.135**	**0.165**	**0.115**	**0.0978**
Thorium 232	NR	NR	NR	NR	NR	NR	-1.13 U	NR	**1.12**	**0.596**	**0.822**
Tin-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 235	NR	NR	NR	NR	NR	NR	-0.111 U	0.0762 U	0.104 U	0.0324 U	0.0268 U
Uranium 238	NR	NR	NR	NR	NR	NR	**1.74**	0.343 U	**0.842**	**0.487**	**0.48**
Uranium-234	NR	NR	NR	NR	NR	NR	0.111 U	0.407 U	**1.00**	**0.534**	**0.398**
Zinc 65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A-3. Concentrations Detected in Soil from Boreholes Located Near 1301-N/1325-N Decayed to January 1, 2001. (Page 4 of 5)

Reference Document:	Quanterra	222-S	222-S	222-S	222-S	222-S	222-S	222-S	222-S	222-S
Location:	199-N-108A	199-N-109A	199-N-109A	199-N-109A	199-N-109A	199-N-109A	199-N-109A	199-N-109A	199-N-109A	199-N-109A
Sample ID:	B0GL79(EB)	B0H1V7	B0H1V8	B0H1V9	B0H1W1	B0H1W2 (Dup)	B0H1W3	B0H1W4	B0H1W5	B0H5N9
Method:										
Sample Collected:	11/15/95	12/19/95	12/20/95	12/20/95	12/22/95	12/22/95	12/22/95	12/27/95	12/27/95	12/28/95
Depth (feet below ground surface):	N/A	8-10	10-12	17-19	24-26	24-26	30	39-41	50	59-61.5
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	2.99 U	**5.26**	**0.969**	1.15 U	**0.981**	1.42 U	**0.912**	1.45 U	**1.15**	0.997 U
Gross beta	2.14 U	**2,440**	**1,610**	**579**	**346**	**319**	**228**	**30.5**	**11.3**	**42.3**
Actinium-228	NR	NR		NR	NR	NR	NR			
Americium 241	NR	**6.46**	NR	NR	NR	NR	NR	NR	NR	NR
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Bismuth-214	NR	NR			NR	NR	NR			
Cadmium-109	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Carbon 14	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	0.0006 U	0.0596 U	0.0259 U	0.0177 U	0.0657 U	0.0378 U	0.0343 U	0.0108 U	0.0118 U	0.0121 U
Cesium 134	-0.0034 U	0.0881 U	0.0194 U	0.0169 U	0.0743 U	0.0342 U	0.0446 U	0.0142 U	0.0157 U	0.0168 U
Cesium 137	0.0120 U	**330**	0.188 U	0.125 U	0.444 U	0.370 U	0.456 U	0.125 U	0.135 U	0.128 U
Chromium 51	-1E-22 U	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt 60	-0.0142 U	**116**	**1.98**	**0.851**	**0.893**	**1.01**	**1.43**	**0.280**	**0.646**	**0.735**
Cobalt-58	-1E-10 U	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium 152	-0.0297 U	NR	NR	NR	NR	NR	NR	NR	NR	NR
Europium 154	0.00584 U	0.706 U	0.223 U	0.193 U	0.808 U	0.440 U	0.458 U	0.178 U	0.229 U	0.210 U
Europium-155	-0.0154 U	0.678 U	0.335 U	0.222 U	0.520 U	0.520 U	0.409 U	0.131 U	0.145 U	0.143 U
Iron 59	-3.5418E-15 U	NR	NR	NR	NR	NR	NR	NR	NR	NR
Lead-214	NR	NR			NR	NR	NR			
Manganese-54	0.000151 U	**0.0188**	0.00220 U	0.00185 U	0.00709 U	0.00356 U	0.00419 U	0.002 U	0.002 U	0.002 U
Plutonium - 238	-0.00584 U	NR	NR	NR	NR	NR	NR	NR	NR	NR
Plutonium 239/240	-0.00186899 U	NR	NR	NR	NR	NR	NR	NR	NR	NR
Potassium 40	**5.68 J**	**10.1**	**9.18**	**6.56**	17.9 U	**7.19**	6.38 U	**9.86**	13.0 U	**13.8**
Radium 226	**0.257 J**	9.30 U	3.27 U	2.29 U	9.98 U	4.82 U	5.22 U	1.77 U	2.01 U	1.98 U
Radium-224DA	**9E-156**	NR	NR	NR	NR	**2E-150**	NR	NR	NR	NR
Radium-226DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228DA		NR	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium 106	U	U	U	U	U	U	U	U	U	U
Ruthenium-103	-6E-16 U	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium 90	**0.242**	**957**	**767**	**293**	**171**	**130**	**113**	**2.07**	**4.09**	**16.0**
Technetium 99	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 228	**0.0416**	5.81 U	2.90 U	1.91 U	4.41 U	4.52 U	3.66 U	1.16 U	1.26 U	1.31 U
Thorium 232	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tin-125	2E-60 U	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 235	-0.00146 U	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 238	**0.0892**	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Zinc 65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Table A-3. Concentrations Detected in Soil from Boreholes Located Near 1301-N/1325-N Decayed to January 1, 2001. (Page 5 of 5)

Reference Document:	Quanterra	Quanterra	Quanterra	Quanterra	Quanterra	Quanterra	Quanterra	Quanterra
Location:	199-N-109A	199-N-109A	199-N-109A	199-N-109A	199-N-109A	199-N-109A	199-N-109A	199-N-109A
Sample ID:	B0GL97	B0GL99	B0GLB1	B0GLB3	B0GLB4 (Dup)	B0GLB6	B0GLC0	B0GLB8 (EB)
Method:								
Sample Collected:	12/19/95	12/20/95	12/20/95	12/22/95	12/22/95	12/27/95	12/28/95	12/27/95
Depth (feet below ground surface):	8-10	10-12	17-19	24-26	24-26	39-41	59.5-61.5	
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	**39.8**	**6.69**	**5.7**	**5.52**	**6.8**	**5.79**	4.53 U	-0.906 U
Gross beta	**3170**	**2450**	**808**	**530**	**491**	**64**	**60.5**	1.53 U
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR
Americium 241	**14.1**	NR	NR	NR	NR	NR	NR	NR
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium-109	NR	NR	NR	NR	NR	NR	NR	NR
Carbon 14	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	0.0266 U	-0.0009 U	-0.0020 U	-0.001 U	-0.001 U	-0.001 U	-0.002 U	-0.0004 U
Cesium 134	**0.117**	-0.0020 U	-0.0004 U	-0.003 U	-0.003 U	0.001 U	-0.006 U	-0.002 U
Cesium 137	**510**	**0.465**	**0.127**	**0.052**	0.030 U	0.003 U	-0.013 U	-0.006 U
Chromium 51	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt 60	**195**	**2.33**	**1.22**	**0.810**	**0.738**	**0.282**	**0.766**	-0.004 U
Cobalt-58	4E-09 U	-5E-10 U	-5E-11 U	1E-10 U	1E-10 U	-6E-10 U	1E-10 U	-2E-10 U
Europium 152	NR	NR	NR	NR	NR	NR	NR	NR
Europium 154	**1.92**	0.00418 U	0.0713 U	0.110 U	0.0868 U	0.0307 U	0.0456 U	-0.00324 U
Europium-155	**0.999**	0.00772 U	0.00673 U	0.0452 U	-0.0114 U	0.0105 U	-0.0101 U	-0.00229 U
Iron 59	0.000 U	0.000 U	0.000 U	-7E-14 U	-7E-14 U	5E-14 U	-3E-14 U	1E-14 U
Lead-214	NR	NR	NR	NR	NR	NR	NR	NR
Manganese-54	**0.046**	0.000 U	-0.0002 U	0.000054 U	0.000398 U	0.000151 U	0.000262 U	0.000353 U
Plutonium - 238	**3.661**	U	0.072 U	U	0.0136 U	-0.00247 U	0.00566 U	-0.00101 U
Plutonium 239/240	**24.087**	0.385 U	0.150 U	0.0246 U	-0.00228 U	U	0.0103 U	-0.00105 U
Potassium 40	**12.5 J**	**9.01 J**	**9.62 J**	**8.03 J**	**7.93 J**	**8.62 J**	**12.4 J**	**4.19 J**
Radium 226	NR	NR	NR	NR	NR	NR	NR	NR
Radium-224DA	NR	**0.000**	**0.000**	**4E-152**	**4E-152**	**1E-151**	**2E-151**	**3E-152**
Radium-226DA	**1.58**	**0.321 J**	**0.367 J**	**0.414 J**	**0.303 J**	**0.357 J**	**0.339 J**	0.116 U
Radium-228	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228DA	NR	NR		NR	NR	NR		NR
Ruthenium 106	U	U	U	U	U	U	U	U
Ruthenium-103	NR	NR	NR	NR	NR	NR	NR	NR
Strontium 90	**1,187**	**1,090**	**355**	**200**	**177**	**24.6**	**14.2**	-0.0115 U
Technetium 99	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 228	0.0852 U	**0.0652**	**0.0669**	**0.0648**	**0.0795**	**0.0921**	**0.0911**	**0.0488**
Thorium 232	-0.167 U	NR	**0.622**	**0.504**	**0.156**	**0.682**	**0.616**	0.134 U
Tin-125	NR	NR	NR	NR	NR	NR	NR	NR
Tritium	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 233/234	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 235	-0.210 UJ	0.085 UJ	0.033 UJ	-0.00422 UJ	0.00763 UJ	0.0169 UJ	0.0291 J	0.00324 UJ
Uranium 238	0.776 U	0.564 U	**0.440**	**0.435**	**0.531**	**0.5**	**0.418**	**0.0278**
Uranium-234	1.36	0.451 U	**0.727**	**0.642**	**0.354**	**0.348**	**0.454**	**0.0509**
Zinc 65	NR	NR	NR	NR	NR	NR	NR	NR

APPENDIX B

VOLUME CALCULATION PACKAGE

CALCULATION COVER SHEET

Project Title Remedial Actions **Job No.** 22192
Area 100-N
Discipline Environmental Engineering ***Calc. No.** 0100N-CA-V0002
Subject Soil Remediation Volume for 1301-N and 1325-N
Computer Program Microsoft Excel **Program No.** Ver. 5

Committed Calculation ☐ **Preliminary** ☒ **Superseded** ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
A	23	J.D. Ludowise J.D. Ludowise 9-16-97	J.G. April 9/19/97	K.E. Cook 9/22/97	H.W. Darby	9/23/97

SUMMARY OF REVISION	

Scanned:	Rev.	Date	Bar Code No.	Rev.	Date	Bar Code No.

*Obtain Calc. No. from DIS.

Bechtel Hanford, Inc. **CALCULATION SHEET**

Originator J. D. Ludowise Date 15-Sep-97 Calc. No. 0100N-CA-V0002 Rev No A
Project Remedial Action Job No. 22192 Checked [illegible] Date 9/19/97
Subject Soil Remediation Volume for 1301-N and 1325-N Sheet No. 1 of 15

Purpose. The purpose of this calculation is to estimate the quantity of contaminated soil and sediment requiring disposal from the remediation of 1301-N and 1325-N. The corrective measures study for 1301-N and 1325-N (Ref. 1) identified remove and dispose as the preferred option for remediating these sites. An engineering study (Ref. 2) was commissioned to evaluate the issues associated with the remove/dispose option and to recommend an optimized remediation option. The purpose of this calculation is to quantify the volume of contaminated media and to calculate the concentration of radioactive contamination associated with these media. The values calculated herein will be used as the basis for a cost estimate and radiation dose assessment for the project.

Input Data.

Crib Dimensions

1301-N Crib:	Drawing H-1-30589
1301-N Trench:	Drawing H-1-28855
1325-N Crib:	Drawing H-1-45090
1325-N Trench:	Drawing H-1-48894, 48895

Radionuclide Concentrations

Surface Sediment:	Tables A2-1 and A3-1 in the Limited Field Investigation (LFI) (Ref. 3).
Soil Borings (199-N-107A, 108A and 109A):	Table A8-1 (Radionuclide Concentrations) and Figures B1-1 through B1-3 (Borehole Logs) in the LFI (Ref. 3).

Assumptions.

The Engineering Study (Ref. 2) makes several key assumptions regarding the character of the contaminated soil beneath the cribs and trenches [these assumptions are discussed further in the engineering study (Ref. 1)]:

1. The 5 ft thick contaminated layer (Ref. 1.) can be broken down into two layers based on activity.

2. The upper layer, containing the bulk of the activity, is 1 ft thick and is referred to as the high activity layer.

3. The 4 ft thick layer immediately below the high activity layer contains radioactive contamination levels significantly less than the high activity layer (low activity layer).

4. The high activity layer is characterized by the average radionuclide concentrations taken from the surface of the 1301-N Trench during the latter years of its operational phase (1980 to 1985). These data are labeled TS-01 through TS-09 in Table A2-1 of the LFI (Ref. 3).

5. In calculating average, ignore data point with 2,800,000 pCi/g Pu-239/240 as being unrepresentative of the whole.

6. The same layers and activities are common to 1301-N and 1325-N Cribs and Trenches.

7. The low activity layer is characterized by the samples collected from borehole 199-N-107A [Table A8-1 of the LFI (Ref. 3)].

8. Operational limit at ERDF would currently restrict alpha emitters (Pu-239/240 and Am-241) concentration to 270 pCi/g [basic assumption in the engineering study (Ref. 2)].

9. Operational limit at ERDF could be raised to 2,000 pCi/g [basic assumption in the engineering study (Ref. 2)].

10. Am-241 concentration is about 25% of the Pu-239/240 concentration.

These assumptions are carried through this calculation.

References.

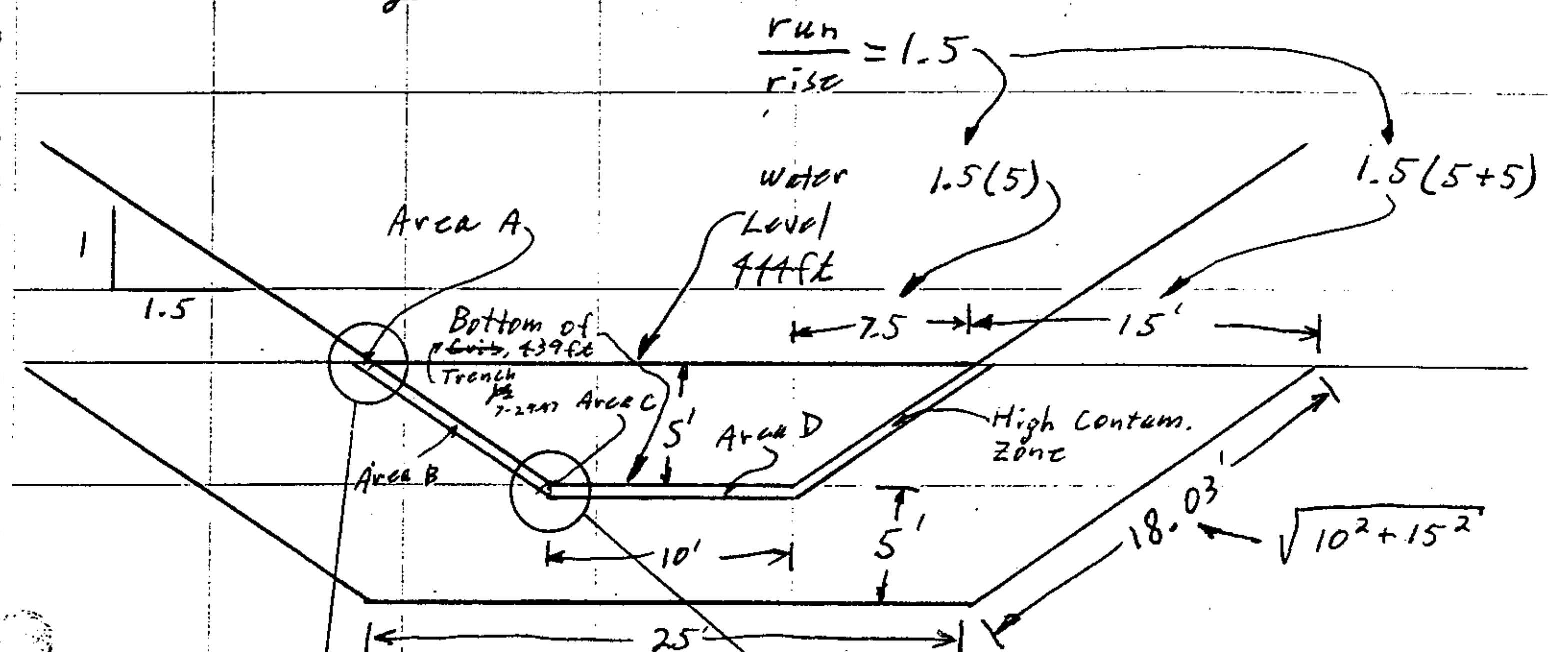
1. DOE/RL-97-39, *100-NR-1 Treatment, Storage, and Disposal Units Corrective Measures Study/Closure Plan,* Draft A.

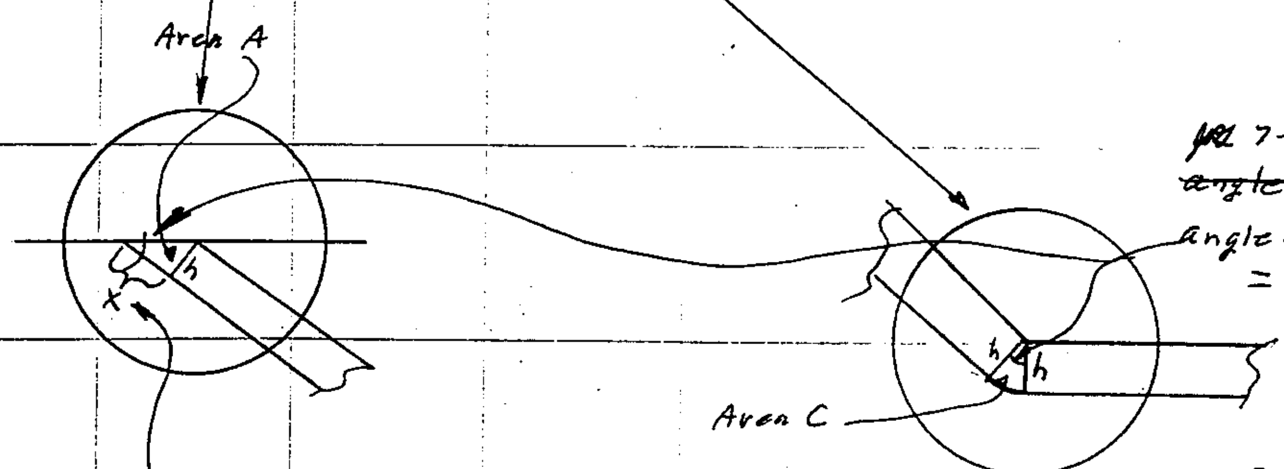
2. BHI-01092, *100-NR-1 Treatment, Storage, and Disposal Units Engineering Study,* Decisional Draft.

3. DOE/RL-96-11, *1301-N and 1325-N Liquid Waste Disposal Facilities Limited Field Investigation Report,* Rev. 0.

Originator J.D. Ludowise Date 7-28-97 Calc. No. 0100N-CA-V0002 Rev. No. A
Project Remedial Action Job No. 22192 Checked [signature] Date 9/19/97
Subject Soil Remediation Volume for 1301-N and 1325-N Sheet No. 3 of 15

1301-N TRENCH
Ref: Dwg H-1-28855.





7-28-97
~~angle = $Tan^{-1}\left(\frac{1.5}{1}\right)$~~
angle = $Tan^{-1}\left(\frac{1}{1.5}\right)$
$= 33.7°$

$X = 1.5h$

$$C\text{-Area} = \frac{\pi (h)^2}{360°}(33.7°) = 0.294\, h^2$$

$$A\text{-Area} = \frac{[1.5(h)](h)}{2} = 0.75\, h^2$$

7-29-97

$$B\text{-Area} = \cancel{\left(\sqrt{1.5^2+1^2}\right) h = 1.8\, h} = \sqrt{[5(1.5)]^2+(5)^2}\; h = 9.01h$$

$$D\text{-Area} = 10\, h$$

Originator J.D. Ludowise Date 7-28-97 Calc. No. 0100N-CA-V0002 Rev. No. A
Project Remedial Action Job No. 22192 Checked [signature] Date 9/19/97
Subject Soil Remediation Volume for 1301-N and 1325-N Sheet No. ~~2~~ 4 of 15 9-16-97

1301-N Trench (continued)

7-28-97

Total Area ~~oo~~ of high contamination zone: 2(A) + 2B + 2C + D

$$= 2(.75h^2 + \cancel{1.8h}\ 9.01h + 0.294h^2) + 10h$$

7-29-97

$$\text{Area} = 2.09h^2 + \cancel{13.6}\ 28.02\, h$$

Total Area of contaminated zone (high + ~~medium~~ low) 9-18-97

$$= \frac{[2(15)+2(7.5)+10]+[25]}{2}(10) - \frac{[2(7.5)+10]+[10]}{2}(5)$$

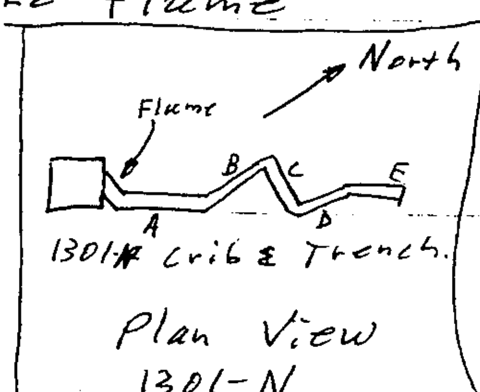
$$= \cancel{6{,}875 - 625 = 6{,}250\ ft^2}$$ 7-28-97

$$= 400 - 87.5 = 312.5\ ft^2$$

Length of 1301-N Trench from: DWG H-1-28855 (9-18-97)

Starting at Crib, we have the flume then lobes "A" Through "E"

	Length, ft
Flume	114
A	288
B	277
C	260
D	194
E	365



Originator J.D. Ludowise Date 9-16-97 Calc. No. 0100N-CA-V0002 Rev. No. A
Project Remedial Action Job No. 22192 Checked [signature] Date 9/19/97
Subject Soil Remediation Volume for 1301-N & 1325-N Sheet No. 5 of 15

1301-N Trench (continued)

The following spreadsheet was used to calculate the volumes based on the formulas developed so far. The spreadsheet calculates the volume for various thicknesses of the high contamination layer.

To use the table, look up the thickness of the high 9-16-97 contamination layer in the upper table and read the volume under total. Then look up the same thickness in the lower table and read the volume of the low contamination layer under total.

For example, high cont. layer thickness is 1 ft. Under "Total" read 45,149 ~~sq.~~ cu ft 9-16-97 ft. for the high cont. layer and 423,434 cu ft under Total for the low cont. layer.

Attachment 3 has sheet showing Formulas for the following table.

1301-N Trench (only)

Originator	J.D. Ludowise	Date	9/16/97	Calc. No.	0100X-CA-V0002
Project	Remedial Action	Job No.	22192	Chck'd By	[signature]
Subject	Soil Remediation Volume for 1301-N and 1325-N				

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	Length, ft	114.44	288.41	277.00	260.19	194.49	364.94	
		Volume of High Contamination Layer, Cubic Feet						
High Contamination Layer Thickness, ft	High Cont. Layer Cross-Sectional Area, sq ft	Flume	Volume A	Volume B	Volume C	Volume D	Volume E	Total
0	0	0	0	0	0	0	0	0
0.5	15	1,663	4,191	4,026	3,781	2,826	5,304	21,791
1	30	3,446	8,684	8,340	7,834	5,856	10,988	45,149
1.5	47	5,348	13,478	12,945	12,159	9,089	17,055	70,074
2	64	7,370	18,573	17,839	16,756	12,525	23,502	96,566
2.5	83	9,511	23,970	23,022	21,625	16,164	30,331	124,624
3	103	11,772	29,668	28,495	26,766	20,007	37,542	154,250
3.5	124	14,153	35,668	34,257	32,179	24,053	45,134	185,443
4	146	16,653	41,969	40,309	37,863	28,302	53,107	218,202
4.5	168	19,273	48,571	46,650	43,820	32,754	61,461	252,529
5	192	22,012	55,475	53,281	50,048	37,409	70,197	288,422
		Volume of Low Contamination Layer, Cubic Feet						
High Contamination Layer Thickness, ft	Low Contamination Layer Cross-Sectional Area, sq ft	Flume	Volume A	Volume B	Volume C	Volume D	Volume E	Total
0	313	35,762	90,127	86,563	81,310	60,777	114,045	468,583
0.5	298	34,099	85,936	82,537	77,529	57,951	108,741	446,792
1	282	32,316	81,443	78,222	73,476	54,921	103,056	423,434
1.5	266	30,414	76,649	73,618	69,151	51,688	96,990	398,509
2	248	28,392	71,554	68,724	64,554	48,252	90,543	372,018
2.5	229	26,251	66,157	63,540	59,685	44,613	83,714	343,959
3	210	23,990	60,459	58,068	54,544	40,770	76,503	314,333
3.5	189	21,609	54,459	52,305	49,131	36,724	68,911	283,140
4	167	19,109	48,158	46,253	43,447	32,475	60,938	250,381
4.5	144	16,489	41,556	39,912	37,490	28,023	52,584	216,054
5	120	13,750	34,652	33,282	31,262	23,368	43,848	180,161

Originator J.D. Ludowise Date Ø7-28-97 Calc. No. 0100N-CA-V0072 Rev. No. A
Project Remedial Action Job No. 22192 Checked [illegible] Date 9/18/97
Subject Soil Remediation Volume for 1301-N & 1325-N Sheet No. 7 of 15

1301-N CRIB

Ref: H-1-30589

Crib is 125 ft by 290 ft.

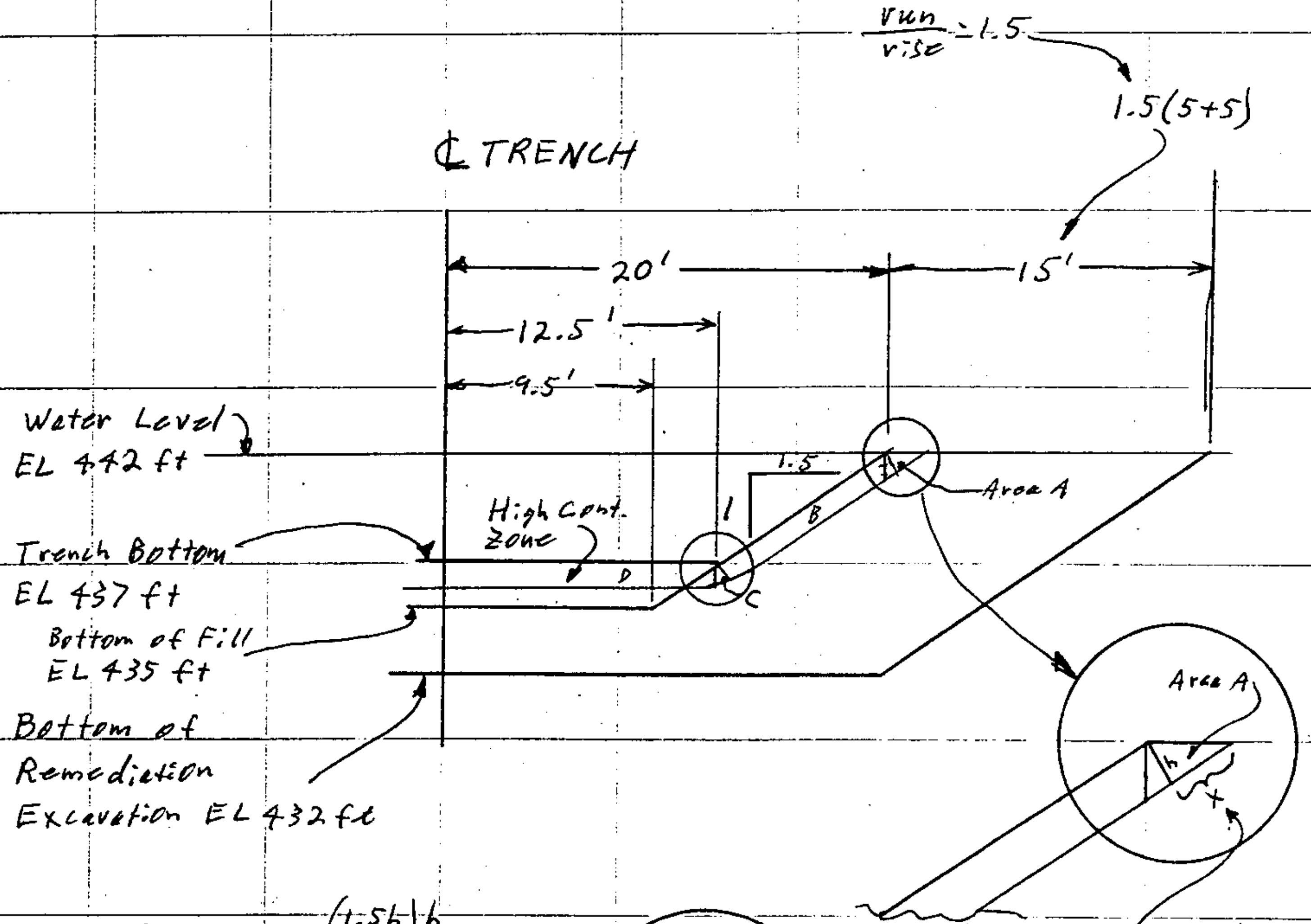
So surface area is 36,250 ft.

Each 6 inch lift has a volume of 18,125 ft^3

For simplicity assumes straight Vertical Walls

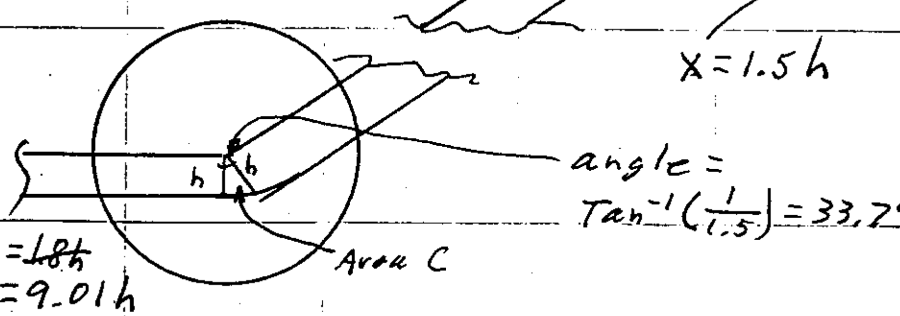
Originator J.D. Ludowise Date 7-29-97 Calc. No. 0100N-CA-V0002 Rev. No. A
Project Remedial Action Job No. 22192 Checked [signature] Date 9/19/97
Subject Remediation Volume for 1301-N & 1325-N Sheet No. 8 of 15

~~130~~ [initials] 9-18-97
1325-N TRENCH



$$A\text{-Area} = \frac{(1.5h)h}{2}$$

$$= 0.75h^2$$



$$B\text{-Area} = \left(\sqrt{[5(1.5)]^2 + (5)^2}\right) h = \cancel{18h}$$
$$= 9.01h$$

$$C\text{-Area} = \frac{\pi h^2}{360°}(33.7°) = 0.294h^2$$

$$D\text{-Area} = \cancel{10}\ 12.5h$$

[initials] 7-29-97

Originator J.D. Ludowise Date 7-29-97 Calc. No 0100N-CA-V0012 Rev. No. A
Project Remedial Action Job No. 22192 Checked [illegible] Date 9/19/97
Subject Remediation Volume for 1304-N & 1325-N Sheet No. 9 of 15

1325-N TRENCH (continued).

Total Area of high contamination zone:

$$2[A+B+C+D] =$$

$$= 2\left[0.75h^2 + 9.01h + 0.294h^2 + 12.5h\right]$$

$$= 2.09h^2 + 43.02h$$

Total Area of contaminated zone (high + medium)

$$= \frac{2(20+15)+2(20)}{2}(\cancel{5}442-432) - \frac{2(20)+2(12.5)}{2}(5)$$

JDL 7-29-97

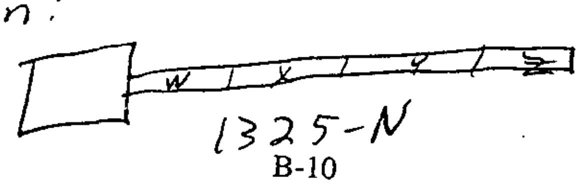
$$= 550 - 162.5 = 387.5 \text{ ft}^2$$

Length of Trench from DWG H-1-48894

Trench is a total of 3000 ft long divided into four sections of equal length by 3 dams.

Each section is 750 ft long.

Divide Trench into sections W, X, Y and Z between Dams As shown:



Originator J.D. Ludowise Date 9-16-97 Calc. No. 0100N-CA-V0002 Rev. No. A
Project Remedial Action Job No. 22192 Checked Date 9/19/97
Subject Soil Remediation Volume for 1301-N & 1325-N Sheet No. 10 of 15

1325-N TRENCH (continued).
Following spreadsheet used to calculate volumes. See page 5 of this calculation for explanation.

Attachment 3 has sheet showing Formulas used in following table.

1325-N Trench, (only)

Originator	J.D. Ludowise	Date	9/16/97	Calc. No.	0100X-CA-V0002
Project	Remedial Action	Job No.	22192	Chck'd By	[illegible]
Subject	Soil Remediation Volume for 1301-N and 1325-N				

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Date 9/19/97
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	Length, ft	750.00	750.00	750.00	750.00	
		Volume of High Contamination Layer, Cubic Feet				
High Contamination Layer Thickness, ft	High Cont. Layer Cross-Sectional Area, sq ft	Volume W	Volume X	Volume Y	Volume Z	Total
0	0	0	0	0	0	0
0.5	22	16,524	16,524	16,524	16,524	66,098
1	45	33,833	33,833	33,833	33,833	135,330
1.5	69	51,924	51,924	51,924	51,924	207,698
		Volume of Low Contamination Layer, Cubic Feet				
High Contamination Layer Thickness, ft	Low Contamination Layer Cross-Sectional Area, sq ft	Volume W	Volume X	Volume Y	Volume Z	Total
0	388	290,625	290,625	290,625	290,625	1,162,500
0.5	365	274,101	274,101	274,101	274,101	1,096,403
1	342	256,793	256,793	256,793	256,793	1,027,170
1.5	318	238,701	238,701	238,701	238,701	954,803

Originator J.D. Ludowise Date 7-29-97 Calc. No 0100N-CA-V0002 Rev. No. A
Project Remedial Action Job No. 22192 Checked [illegible] Date 9/19/97
Subject Remediation Volume for 1301-N & 1325-N Sheet No. 12 of 15

1325-N CRIB

Ref: H-1-45090

Crib is 240 ft by 250 ft

So surface area is 60,000 ft^2

Each 6 inch lift has a volume of 30,000 ft^3

Assume straight sides (vertical sides) for simplicity of calculation.

VOLUMES

The ERDF is currently restricted to about 270 pCi of α emitters (assumption ~~8~~ 8X pz 9-16-97, page 2, this calc.) The limit may reasonably be expected to be raised to 2000 pCi/g (assumption 9, page 2).

Upper 1 ft layer

Calculate Average Pu conc. from Table A2-1, DOE/RL-96-11 (Attachment 1 to this calc.)

Sum of 35 results is ~~4,222,700~~ 1,422,700 pz 9-16-97 pCi/g (excludes 2,800,000 value per assumption #5, page 2, this calc.)

Average is then $\frac{\cancel{4,222,700}\ 1,422,700}{35} = 40,649$ pCi/g pz 9-16-97

This represents Average Pu conc in upper 1 ft layer.
Estimated Am-241 conc is 25% of this (Assumption # 10) or 10,162 pCi/g

Total α = 40,649 + 10,162 = 50,811 pCi/g.

Lower 4 ft layer

Calc. Average Pu conc from Table A8-1, DOE/RL-96-11 (Att. 2 to this calc) using 9 – 13' interval data from ~~W~~ pz 9-16-97 boring 199-N-107A.

B0GL88	1590
B0GL89	3340
B0GLF5	689
Sum	5,619

Avg = $\frac{5619}{3}$ = 1873 pCi/g.

Originator J.D. Ludowise **Date** 9-16-97 **Calc. No.** 0100N-CA-V0002 **Rev. No.** A
Project Remedial Action **Job No.** 22192 **Checked** [illegible] **Date** 9/19/97
Subject Soil Remediation Volume for 1301-N & 1325-N **Sheet No.** 14 of 15

VOLUMES

Following spreadsheet table calculates Volumes assuming ERDF limits of 270, 1080 and 2000 pCi/g.

Attachment 3 has sheet showing Formulas used in following table.

Volumes

Originator	J.D. Ludowise	Date	9/16/97	Calc. No.	0100X-CA-V0002
Project	Remedial Action	Job No.	22192	Chck'd By	[signature]
Subject	Soil Remediation Volume for 1301-N and 1325-N				

Rev No.	A
Date	7/15/97
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	ERDF Operational Limit, pCi/g	Pu-239 Conc., pCi/g	Estimated Am-241 Conc., pCi/g	Dilution Factor	Volume, Cubic Feet					Total Volume, Cubic Yards
					1301-N Crib	1301-N Trench	1325-N Crib	1325-N Trench	Total	
High Exposure		40,649	10,162		36,250	45,149	60,000	33,833	175,231	6,490
Low Exposure		1,873	468		145,000	423,434	240,000	256,793	1,065,227	39,453
Total					181,250	468,583	300,000	290,625	1,240,458	45,943
High Exposure	270			188.2	6,821,881	8,496,569	11,291,389	6,366,932	32,976,770	1,221,362
Low Exposure				8.7	1,257,338	3,671,724	2,081,111	2,226,724	9,236,897	342,107
Total					8,079,219	12,168,293	13,372,500	8,593,656	42,213,667	1,563,469
High Exposure	1080			47.0	1,705,470	2,124,142	2,822,847	1,591,733	8,244,193	305,340
Low Exposure				2.2	314,334	917,931	520,278	556,681	2,309,224	85,527
Total					2,019,805	3,042,073	3,343,125	2,148,414	10,553,417	390,867
High Exposure	2000			25.4	920,954	1,147,037	1,524,338	859,536	4,451,864	164,884
Low Exposure				1.2	169,741	495,683	280,950	300,608	1,246,981	46,184
Total					1,090,695	1,642,720	1,805,288	1,160,144	5,698,845	211,068

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Attachment 1
Originator J.D. Ludowise
Chk'd By [illegible]
Calc. No. 0100N-CA-V0002
Sheet No. 1 of 2
Date 9-16-97
Date 9/18/97
Rev. No. A

Table A2-1. Radionuclides Concentrations Detected in 1301-N Trench Sediment from 1980 to 1985 from Locations TS-01 to TS-09 (Page 1 of 2)

Location:	TS-01	TS-02	TS-03	TS-04	TS-05	TS-06	TS-07	TS-08	TS-09
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Collection Date:					1980				
Gross alpha	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gross beta	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cerium-144	11,000,000	4,100,000	1,100,000	800,000	510,000	860,000	410,000	ND	330,000
Cesium-134	NA	NA	NA	NA	41,000	NA	NA	NA	NA
Cesium-137	270,000	210,000	120,000	220,000	260,000	210,000	240,000	630,000	350,000
Cobalt-58	250,000		NA	NA	NA	NA	NA	NA	NA
Cobalt-60	13,000,000	8,200,000	8,400,000	5,100,000	3,100,000	5,600,000	1,700,000	7,600,000	4,300,000
Europium-154	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron-59	NA	330,000	NA	NA	NA	NA	NA	NA	NA
Manganese-54	4,400,000	2,800,000	1,600,000	1,000,000	610,000	1,100,000	350,000	430,000	700,000
Niobium-95	3,600,000	1,500,000	220,000	260,000	140,000	270,000	92,000	ND	120,000
Plutonium-238	NA	NA	NA	NA	NA	NA	NA	NA	NA
Plutonium-239/240	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ruthenium-103	NA	110,000	NA	NA	NA	NA	NA	NA	NA
Ruthenium-106	2,700,000	870,000	NA	NA	NA	NA	NA	NA	NA
Strontium-90	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zirconium-95	1,980,000	790,000	NA	NA	NA	NA	NA	NA	NA
Collection Date:					1981				
Gross alpha	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gross beta	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cerium-144	2,700,000	1,100,000	NR	1,200,000	440,000	770,000	840,000	790,000	110,000
Cesium-134	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cesium-137	190,000	190,000	530,000	330,000	490,000	570,000	530,000	440,000	780,000
Cobalt-58	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt-60	6,600,000	6,300,000	19,000,000	6,000,000	4,400,000	17,000,000	8,900,000	5,400,000	8,300,000
Europium-154	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron-59	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese-54	1,300,000	1,100,000	1,700,000	980,000	390,000	1,300,000	900,000	750,000	990,000
Niobium-95	140,000	90,000	NA	NA	NA	NA	NA	NA	NA
Plutonium-238	5,500	1,500	6,200	1,800	780	4,900	6,300	1,200	4,000
Plutonium-239/240	26,000	9,200	25,000	12,000	5,500	25,000	30,000	6,600	20,000
Ruthenium-103	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ruthenium-106	750,000	NA	NA	NA	NA	NA	NA	NA	NA
Strontium-90	170,000	770,000	110,000	36,000	21,000	96,000	110,000	25,000	45,000
Zirconium-95	NA	NA	NA	NA	NA	NA	NA	NA	NA
Collection Date:					1982				
Gross alpha	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gross beta	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cerium-144	NA	2,100,000	NA	NA	NA	NA	NA	NA	1,300,000
Cesium-134	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cesium-137	940,000	490,000	940,000	530,000	540,000	500,000	1,000,000	460,000	560,000
Cobalt-58	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt-60	21,000,000	27,000,000	34,000,000	6,400,000	6,600,000	15,000,000	14,000,000	4,500,000	4,300,000
Europium-154	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron-59	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese-54	710,000	1,900,000	860,000	460,000	460,000	470,000	490,000	270,000	ND
Niobium-95	NA	NA	NA	NA	NA	NA	NA	NA	NA
Plutonium-238	5,500	14,000	29,000	510,000	120,000	9,300	3,800	9,500	1,100
Plutonium-239/240	28,000	63,000	170,000	2,900,000	660,000	44,000	17,000	16,000	13,000
Ruthenium-103	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ruthenium-106	NA	NA	NA	NA	NA	NA	NA	NA	NA
Strontium-90	110,000	250,000	320,000	150,000	110,000	230,000	83,000	70,000	150,000
Zirconium-95	NA	NA	NA	NA	NA	NA	NA	NA	NA

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Attachment 1 Sheet No. 2 of 2
Originator J.D. Ludowise Date 9-16-97
Chk'd By [illegible] Date 9/19/97
Calc. No. 0100N-CA-V0002 Rev. No. A

Table A2-1. Radionuclides Concentrations Detected in 1301-N Trench Sediment from 1980 to 1985 from Locations TS-01 to TS-09 (Page 2 of 2)

Location:	TS-01	TS-02	TS-03	TS-04	TS-05	TS-06	TS-07	TS-08	TS-09
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Collection Date:	1983								
Gross alpha	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gross beta	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cerium-144	NA	NA	NA	380,000	NA	NA	NA	NA	NA
Cesium-134	ND	ND	ND	ND	28,000	ND	37,000	28,000	NA
Cesium-137	83,000,000	550,000	580,000	380,000	720,000	950,000	800,000	400,000	390,000
Cobalt-58	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt-60	22,000,000	16,000,000	25,000,000	8,000,000	5,200,000	16,000,000	6,000,000	4,000,000	4,000,000
Europium-154	130,000	ND	ND	54,000	80,000	170,000	ND	ND	ND
Iron-59	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese-54	610,000	410,000	620,000	940,000	130,000	300,000	140,000	170,000	220,000
Niobium-95	NA	NA	NA	120,000	NA	NA	NA	NA	NA
Plutonium-238	2,400	3,000	1,900	1,500	560	2,000	1,100	830	920
Plutonium-239/240	12,000	13,000	10,000	7,500	3,000	9,800	6,200	4,600	4,300
Ruthenium-103	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ruthenium-106	NA	NA	NA	NA	NA	NA	NA	NA	NA
Strontium-90	46,000	46,000	29,000	26,000	13,000	46,000	27,000	13,000	8,700
Zirconium-95	NA	NA	NA	NA	NA	NA	NA	NA	NA
Collection Date:	1984								
Gross alpha	NA	NA	NA	NA	NA	NA	NA	NA	NA
Gross beta	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cerium-144	NA	NA	NA	NA	NA	NA	870,000	NA	NA
Cesium-134	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cesium-137	3,100,000	960,000	820,000	750,000	1,300,000	750,000	900,000	730,000	1,300,000
Cobalt-58	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt-60	53,000,000	22,000,000	32,000,000	16,000,000	8,300,000	23,000,000	16,000,000	16,000,000	15,000,000
Europium-154	NA	NA	NA	NA	150,000	NA	NA	NA	NA
Iron-59	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese-54	790,000 U	470,000	520,000	1,300,000	190,000 U	350,000	3,200,000	750,000	1,100,000
Niobium-95	NA	NA	NA	NA	NA	NA	NA	NA	NA
Plutonium-238	NA	NA	NA	NA	NA	NA	NA	NA	NA
Plutonium-239/240	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ruthenium-103	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ruthenium-106	NA	NA	NA	NA	NA	NA	NA	NA	NA
Strontium-90	NA	NA	NA	NA	NA	NA	NA	NA	NA
Zirconium-95	NA	NA	NA	NA	NA	NA	NA	NA	NA
Collection Date:	1985								
Gross alpha	35,000	28,000	52,000	38,000	34,000	42,000	19,000	18,000	28,000
Gross beta	1,900,000	19,000,000	13,000,000	6,500,000	5,000,000	10,000,000	6,000,000	2,800,000	2,300,000
Cerium-144	87,000 U	67,000 U	84,000 U	85,000 U	69,000 U	79,000 U	50,000	11,000 U	63,000 U
Cesium-134	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cesium-137	29,000	26,000	37,000	28,000	55,000	68,000	56,000	22,000	25,000
Cobalt-58	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cobalt-60	1,300,000	1,100,000	1,600,000	1,200,000	950,000	1,100,000	1,300,000	260,000	640,000
Europium-154	NA	NA	NA	NA	NA	NA	NA	NA	NA
Iron-59	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese-54	54,000	17,000	23,000 U	100,000	56,000	18,000 U	150,000	28,000	40,000
Niobium-95	NA	NA	NA	NA	NA	NA	NA	NA	NA
Plutonium-238	4,600	2,900	5,100	4,000	3,900	4,200	2,300	1,800	3,400
Plutonium-239/240	26,000	16,000	27,000	23,000	21,000	24,000	14,000	11,000	28,000
Ruthenium-103	NA	NA	NA	NA	NA	NA	NA	NA	NA
Ruthenium-106	NA	NA	NA	NA	NA	NA	NA	NA	NA
Strontium-90	93,000	77,000	210,000	110,000	190,000	120,000	120,000	70,000	110,000
Zirconium-95	NA	NA	NA	NA	NA	NA	NA	NA	NA

U = Concentration was undetected at specified detection level.
NA = Not analyzed
ND = Not detected; no detection limit given
NR = Not reported
Trench sediment samples collected by attaching a jar to a pole and using this device as a scoop. The top six inches of trench sediments were sampled through standing water.

References:
UNI-1581 = Radiological Surveillance Report for the 100-N Area-FY 1980
UNI-1849 = UNC Environmental Surveillance Report for 100 Areas-FY 1981
UNI-2226 = UNC Environmental Surveillance Report for 100 Areas-FY 1982
UNI-2640 = UNC Environmental Surveillance Report for 100 Areas-FY 1983
UNI-3069 = UNC Environmental Surveillance Report for 100 Areas-FY 1984
UNI-3760 = UNC Environmental Surveillance Report for 100 Areas-FY 1985

Attachment 2 Sheet No. 1 of 2
Originator J.D. Ludowise Date 9-16-97
Chk'd By Date 9/15/97
Calc. No. 0100N-CA-V0002 Rev. No. A
Draft A

Table A8-1. Concentrations Detected in Soil from Wells and Boreholes Located Near 1301-N/1325-N (Page 14 of 23)

Data Source:	222-S	222-S	222-S	222-S	222-S	222-S	222-S	222-S	222-S	222-S	HEIS
Location:	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-107A
Sample ID:	B0GGC3*	B0GLF4	B0GLF5	B0GLF7	B0GLF6	B0GLF8 (Dup)	B0GLF9	B0GLG0	B0GLG1	B0H1V6	B0GL88
Method:											
Sample Collected:	8/25/95	11/29/95	11/30/95	12/5/95	12/5/95	12/5/95	12/6/95	12/6/95	12/8/95	12/8/95	11/29/95
Elevation (feet above mean sea level):	N/A	451-449	449-447	437	432-430	432-430	420	410	403-401	391	451-449
Depth (feet below ground surface):	N/A	9-11	11-13	23	28-30	28-30	40	50	57-59	69	9.0-11.0
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	13,900	941	38,200	2.52 U	2.18 U	3.39 U	1.44 U	0.968 U	1.96 U	2.77	1,980
Gross beta	305,000	63,700	60,600	4,310	2,810	2,490	1,680	145	124	123	128,000
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Americium 241	17,300	856	1,130	NR	NR	NR	NR	NR	NR	NR	1,110
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium-109	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Carbon 14	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	NR	456 U	402 U	11.2 U	6.5 U	NR	2.51 U	1.17 U	2.44 U	2.45 U	-130 U
Cesium 134	NR	97.9 U	87.8 U	2.61	0.282 U	0.225 U	0.097 U	0.076 U	0.144 U	0.161 U	31.1 U
Cesium 137	102,000	12,100	15,100	2,790	5.81	5.69	0.143 U	NR	0.41 U	0.421 U	15,800
Chromium 51	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt 60	56,300	107,000	132,000	23.9	5.82	5.25	1.2	0.786	1.15	0.709	139,000
Cobalt-58	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-120 U
Europium 152	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	2.85 U
Europium 154	11,800	1,030	1,370	0.978 U	0.557 U	0.567 U	0.286 U	0.294 U	0.524 U	0.49 U	990
Europium-155	4120	355	384	5.55 U	2.01 U	1.85 U	0.716 U	0.332 U	0.703 U	0.697 U	287
Iron 59	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-40 U
Lead-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Manganese-54	NR	140 U	127 U	0.568 U	0.265 U	0.258 U	0.097 U	0.105 U	0.241 U	18.3 U	56.8 U
Plutonium - 238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	226
Plutonium 239/240	12,700	NR	689	NR	NR	NR	NR	NR	NR	NR	1,590
Potassium 40	NR	422 U	457 U	0.11	7.02 U	NR	11.6	2.05	16.9	17	879
Radium 226	NR	1,410 U	1,260 U	45 U	6.77 U	9.28 U	3.36 U	2.07 U	4.94 U	4.53 U	NR
Radium-224DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-226DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	104 U
Radium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228DA	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ruthenium 106	NR	1,930 U	1,740 U	29 U	4.81 U	4.69 U	1.85 U	1.76 U	3.52 U	3.36 U	103 U
Ruthenium-103	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium 90	92,299	3,250	12,600	1,170	1,550	1,350	1,080	188	63.1	54.6	9,560
Technetium 99	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 228	NR	5,270 U	4,650 U	152	54.2 U	50.4	19.9 U	8.84 U	20.6 U	18.2 U	35.5 U
Thorium 232	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	62.2 U
Tin-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 235	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	0.677 U
Uranium 238	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	-0.226 U
Uranium-234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	10.5 U
Zinc 65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Attachment 2
Originator J.D. Ludowise
Chk'd By
Calc. No. 0100N-CA-V0002
Sheet No. 2 of 2
Date 9-16-97
Date 9/19/97
Rev. No. 0

Table A8-1. Concentrations Detected in Soil from Wells and Boreholes Located Near 1301-N/1325-N (Page 15 of 23)

Data Source:	HEIS	HEIS	HEIS	HEIS	HEIS	222-S	222-S	222-S	222-S	222-S	222-S
Location:	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-107A	199-N-108A	199-N-108A	199-N-108A	199-N-108A	199-N-108A	199-N-108A
Sample ID:	B0GL89	B0GL91	B0GL92 (Dup)	B0GL95	B0GL94 (EB)	B0GLD2	B0GLD5	B0GLD3	B0GLD4 (Dup	B0GLD6	B0GLD7
Method:											
Sample Collected:	11/30/95	12/5/95	12/5/95	12/8/95	12/8/95	11/9/95	11/9/95	11/10/95	11/10/95	11/10/95	11/10/95
Elevation (feet above mean sea level):	449-447	432-430	432-430	403-401	--	443-441	439	434-432	434-432	429	424.5
Depth (feet below ground surface):	11.0-13.0	28-30	28.30	57-59	N/A	14.5-16.5	18	23-25	23-25	28	32.5
Units:	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g	pCi/g
Gross alpha	2,530	7.43	6.43 U	6.61	3.62 U	1.4	51.1	1.33 U	1.45 U	1.31 U	1.38 U
Gross beta	131,000	4,480	5,120	293	2.88	2,280	17,600	2,690	2,770	435	228
Actinium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Americium 241	1,050	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Antimony-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Bismuth-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cadmium-109	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Carbon 14	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cerium-144	62.9 U	-0.57 U	0.0968 U	-0.0378 U	-0.103 U	66.7 U	107 U	22 U	15.5 U	12 U	6.89 U
Cesium 134	4.84 U	-0.01 U	-0.0459 U	-0.0177 U	-0.00734 U	5.54 U	17.1	1.5 U	1.32 U	0.962 U	0.622 U
Cesium 137	12,500	2.46	6.01	0.0144 U	0.0116 U	3,200	15,700	108	84.9	24.1	1.34 U
Chromium 51	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Cobalt 60	120,000	4.96	5.57	1.29	-0.00425 U	522	3,300	10.4	14.2	3.53	0.999 U
Cobalt-58	-100 U	0.0383 U	-0.00793 U	0.0116	-0.0553 U	NR	NR	NR	NR	NR	NR
Europium 152	71.7 U	0.0936 U	-0.207 U	0.0341 U	0.0453 U	NR	NR	NR	NR	NR	NR
Europium 154	807	0.155 U	0.147 U	0.0133 U	-0.0017 U	9.05 U	18.3 U	3.99 U	3.64 U	2.2 U	1.61 U
Europium-155	141	0.0209 U	0.133 U	0.0133 U	0.0359 U	16.1 U	24.1 U	6.09 U	4.21 U	3.18 U	1.66 U
Iron 59	142 U	-0.28 U	-0.04 U	0.07 U	-0.09560 U	NR	NR	NR	NR	NR	NR
Lead-214	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Manganese-54	19.3 U	0.0983 U	0.047 U	0.0357 U	-0.0116 U	5.05 U	9.49 U	1.35 U	0.978 U	0.943 U	0.591 U
Plutonium - 238	465	-0.00126 U	0.00823 U	0.00339 U	-0.000822 U	NR	11.2	NR	NR	NR	NR
Plutonium 239/240	3,340	0.023 U	0.0708	-0.00156 U	0.00472 U	NR	73.7	NR	NR	NR	NR
Potassium 40	55.4	9.33	9.93	15.7	0.488	43.1 U	43.3 U	48.4 U	13 U	35.4 U	15.7 U
Radium 226	NR	NR	NR	NR	NR	121 U	200 U	36.1 U	27.1 U	20.8 U	11.7 U
Radium-224DA	NR	NR	0.552 U	0.435	0.0857	NR	NR	NR	NR	NR	NR
Radium-226DA	25 U	0.346 J	0.369 J	0.365 J	0.189 J	NR	NR	NR	NR	NR	NR
Radium-228	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Radium-228DA	NR	NR	NR	0.562	NR	NR	NR	NR	NR	NR	NR
Ruthenium 106	-425 U	0.403 U	-0.203 U	-0.146 U	-0.0924 U	109 U	184 U	31.4 U	16.1 U	20 U	10.6 U
Ruthenium-103	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Strontium 90	19,700	1,530	1,310	50	0.0771 U	139	785	1,410	1,380	195	119
Technetium 99	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Thorium 228	144 U	0.47	0.402	0.462	0.179	427 U	651 U	165 U	115 U	81 U	51.7 U
Thorium 232	-156 U	1.08	0.388 U	0.624	NR	NR	NR	NR	NR	NR	NR
Tin-125	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Tritium	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 233/234	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Uranium 235	-0.672 U	0.0227 U	0.00386 U	0.0193 U	0.00388 U	NR	NR	NR	NR	NR	NR
Uranium 238	9.99 U	0.363	0.441	0.364	0.0127 U	NR	NR	NR	NR	NR	NR
Uranium-234	5.12 U	0.414	0.479	0.302	0.0347	NR	NR	NR	NR	NR	NR
Zinc 65	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR

Attachment 3 Sheet No. 1 of 3
Originator J. D. Ludowise Date 9-17-97
Chk'd By [signature] Date 9/19/97
Calc. No. 0100N-CA-V0002 Rev. No. A

	C	D	E	F	G	H	I	J	K	L	M
12		Length, ft	114.43775600736	288.40596387731	277	260.192236625154	194.486503387767	364.943831294625			
13											
14	High Contamination Layer Thickness, ft	High Cont. Layer Cross-Sectional Area, sq ft	Flume	Volume A	Volume B	Volume C	Volume D	Volume E	Total		
15	0	=2.09*C15^2+28.02*C15	=E$12*$D15	=F$12*$D15	=G$12*$D15	=H$12*$D15	=I$12*$D15	=J$12*$D15	=SUM(E15:J15)		
16	0.5	=2.09*C16^2+28.02*C16	=E$12*$D16	=F$12*$D16	=G$12*$D16	=H$12*$D16	=I$12*$D16	=J$12*$D16	=SUM(E16:J16)		
17	1	=2.09*C17^2+28.02*C17	=E$12*$D17	=F$12*$D17	=G$12*$D17	=H$12*$D17	=I$12*$D17	=J$12*$D17	=SUM(E17:J17)		
18	=0.5+C17	=2.09*C18^2+28.02*C18	=E$12*$D18	=F$12*$D18	=G$12*$D18	=H$12*$D18	=I$12*$D18	=J$12*$D18	=SUM(E18:J18)		
19	=0.5+C18	=2.09*C19^2+28.02*C19	=E$12*$D19	=F$12*$D19	=G$12*$D19	=H$12*$D19	=I$12*$D19	=J$12*$D19	=SUM(E19:J19)		
20	=0.5+C19	=2.09*C20^2+28.02*C20	=E$12*$D20	=F$12*$D20	=G$12*$D20	=H$12*$D20	=I$12*$D20	=J$12*$D20	=SUM(E20:J20)		
21	=0.5+C20	=2.09*C21^2+28.02*C21	=E$12*$D21	=F$12*$D21	=G$12*$D21	=H$12*$D21	=I$12*$D21	=J$12*$D21	=SUM(E21:J21)		
22	=0.5+C21	=2.09*C22^2+28.02*C22	=E$12*$D22	=F$12*$D22	=G$12*$D22	=H$12*$D22	=I$12*$D22	=J$12*$D22	=SUM(E22:J22)		
23	=0.5+C22	=2.09*C23^2+28.02*C23	=E$12*$D23	=F$12*$D23	=G$12*$D23	=H$12*$D23	=I$12*$D23	=J$12*$D23	=SUM(E23:J23)		
24	=0.5+C23	=2.09*C24^2+28.02*C24	=E$12*$D24	=F$12*$D24	=G$12*$D24	=H$12*$D24	=I$12*$D24	=J$12*$D24	=SUM(E24:J24)		
25	=0.5+C24	=2.09*C25^2+28.02*C25	=E$12*$D25	=F$12*$D25	=G$12*$D25	=H$12*$D25	=I$12*$D25	=J$12*$D25	=SUM(E25:J25)		
26											
27											
28	High Contamination Layer Thickness, ft	Low Contamination Layer Cross-Sectional Area, sq ft	Flume	Volume A	Volume B	Volume C	Volume D	Volume E	Total		
29	=C15	=312.5-D15	=E$12*$D29	=F$12*$D29	=G$12*$D29	=H$12*$D29	=I$12*$D29	=J$12*$D29	=SUM(E29:J29)		
30	=C16	=312.5-D16	=E$12*$D30	=F$12*$D30	=G$12*$D30	=H$12*$D30	=I$12*$D30	=J$12*$D30	=SUM(E30:J30)		
31	=C17	=312.5-D17	=E$12*$D31	=F$12*$D31	=G$12*$D31	=H$12*$D31	=I$12*$D31	=J$12*$D31	=SUM(E31:J31)		
32	=C18	=312.5-D18	=E$12*$D32	=F$12*$D32	=G$12*$D32	=H$12*$D32	=I$12*$D32	=J$12*$D32	=SUM(E32:J32)		
33	=C19	=312.5-D19	=E$12*$D33	=F$12*$D33	=G$12*$D33	=H$12*$D33	=I$12*$D33	=J$12*$D33	=SUM(E33:J33)		
34	=C20	=312.5-D20	=E$12*$D34	=F$12*$D34	=G$12*$D34	=H$12*$D34	=I$12*$D34	=J$12*$D34	=SUM(E34:J34)		
35	=C21	=312.5-D21	=E$12*$D35	=F$12*$D35	=G$12*$D35	=H$12*$D35	=I$12*$D35	=J$12*$D35	=SUM(E35:J35)		
36	=C22	=312.5-D22	=E$12*$D36	=F$12*$D36	=G$12*$D36	=H$12*$D36	=I$12*$D36	=J$12*$D36	=SUM(E36:J36)		
37	=C23	=312.5-D23	=E$12*$D37	=F$12*$D37	=G$12*$D37	=H$12*$D37	=I$12*$D37	=J$12*$D37	=SUM(E37:J37)		
38	=C24	=312.5-D24	=E$12*$D38	=F$12*$D38	=G$12*$D38	=H$12*$D38	=I$12*$D38	=J$12*$D38	=SUM(E38:J38)		
39	=C25	=312.5-D25	=E$12*$D39	=F$12*$D39	=G$12*$D39	=H$12*$D39	=I$12*$D39	=J$12*$D39	=SUM(E39:J39)		

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1325-N Trench

	C	D	E	F	G	H	I
12		Length, ft	750	750	750	750	
13							
14	High Contamination Layer Thickness, ft	High Cont. Layer Cross- Sectional Area, sq ft	Volume W	Volume X	Volume Y	Volume Z	Total
15	0	=2.09*C15^2+43.02*C15	=E$12*$D15	=F$12*$D15	=G$12*$D15	=H$12*$D15	=SUM(E15:H15)
16	0.5	=2.09*C16^2+43.02*C16	=E$12*$D16	=F$12*$D16	=G$12*$D16	=H$12*$D16	=SUM(E16:H16)
17	1	=2.09*C17^2+43.02*C17	=E$12*$D17	=F$12*$D17	=G$12*$D17	=H$12*$D17	=SUM(E17:H17)
18	1.5	=2.09*C18^2+43.02*C18	=E$12*$D18	=F$12*$D18	=G$12*$D18	=H$12*$D18	=SUM(E18:H18)
19							
20							
21	High Contamination Layer Thickness, ft	Low Contamination Layer Cross-Sectional Area, sq ft	Volume W	Volume X	Volume Y	Volume Z	Total
22	=C15	=387.5-D15	=E$12*$D22	=F$12*$D22	=G$12*$D22	=H$12*$D22	=SUM(E22:H22)
23	=C16	=387.5-D16	=E$12*$D23	=F$12*$D23	=G$12*$D23	=H$12*$D23	=SUM(E23:H23)
24	=C17	=387.5-D17	=E$12*$D24	=F$12*$D24	=G$12*$D24	=H$12*$D24	=SUM(E24:H24)
25	=C18	=387.5-D18	=E$12*$D25	=F$12*$D25	=G$12*$D25	=H$12*$D25	=SUM(E25:H25)

Attachment 3 Sheet No. 2 of 3
Originator J.D. Ludowise Date 9-16-97
Chk'd By Date 9/19/97
Calc. No. 0100N-CA-V0002 Rev. No. A

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	A	B	C	D	E	F	G	H	I	J	K
~~10~~						Volume, Cubic Feet					
11		ERDF Oper-ational Limit, pCi/g	Pu-239 Conc., pCi/g	Estimated Am-241 Conc., pCi/g	Dilution Factor	1301-N Crib	sheet #1 This Attachment. 1301-N Trench	1325-N Crib	Sheet #2 This Attachment 1325-N Trench	Total	Total Volume, Cubic Yards
12 ~~11~~	High Exposure		40649	=0.25*C12		=36250	='[VOLUMES.XLS]1301-N Trench'!$K$17	60000	='[VOLUMES.XLS]1325-N Trench'!$E$17	=SUM(F12:I12)	=J12/27
13 ~~12~~	Low Exposure		1873	=0.25*C13		=4*36250	='[VOLUMES.XLS]1301-N Trench'!$K$31	=4*60000	='[VOLUMES.XLS]1325-N Trench'!$E$24	=SUM(F13:I13)	=J13/27
14 ~~13~~	Total					=SUM(F12:F13)	=SUM(G12:G13)	=SUM(H12:H13)	=SUM(I12:I13)	=SUM(J12:J13)	=SUM(K12:K13)
15 ~~14~~	High Exposure	270			=($C12+$D12)/$B$15	=F12*$E15	=G12*$E15	=H12*$E15	=I12*$E15	=SUM(F15:I15)	=J15/27
16 ~~15~~	Low Exposure				=($C13+$D13)/$B$15	=F13*$E16	=G13*$E16	=H13*$E16	=I13*$E16	=SUM(F16:I16)	=J16/27
17 ~~16~~	Total					=SUM(F15:F16)	=SUM(G15:G16)	=SUM(H15:H16)	=SUM(I15:I16)	=SUM(J15:J16)	=SUM(K15:K16)
18 ~~17~~	High Exposure	1080			=($C12+$D12)/$B$18	=F12*$E18	=G12*$E18	=H12*$E18	=I12*$E18	=SUM(F18:I18)	=J18/27
19 ~~18~~	Low Exposure				=($C13+$D13)/$B$18	=F13*$E19	=G13*$E19	=H13*$E19	=I13*$E19	=SUM(F19:I19)	=J19/27
20 ~~19~~	Total					=SUM(F18:F19)	=SUM(G18:G19)	=SUM(H18:H19)	=SUM(I18:I19)	=SUM(J18:J19)	=SUM(K18:K19)
21 ~~20~~	High Exposure	2000			=($C12+$D12)/$B$21	=F12*$E21	=G12*$E21	=H12*$E21	=I12*$E21	=SUM(F21:I21)	=J21/27
22 ~~21~~	Low Exposure				=($C13+$D13)/$B$21	=F13*$E22	=G13*$E22	=H13*$E22	=I13*$E22	=SUM(F22:I22)	=J22/27
23 ~~22~~	Total					=SUM(F21:F22)	=SUM(G21:G22)	=SUM(H21:H22)	=SUM(I21:I22)	=SUM(J21:J22)	=SUM(K21:K22)

JDL 9-17-97

Attachment 3 Sheet No. 3 of 3
Originator J.D. Ludowise Date 9-16-97
Chk'd By [signature] Date 9/19/97
Calc. No. 0100N-CA-V0002 Rev. No. 0

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APPENDIX C

DOSE CALCULATION PACKAGE

CALCULATION COVER SHEET

Project Title: 100NR-1 Treatment, Storage, and Disposal Units Engineering Study **Job No.** 22192
Area 100N , Remedial Actions and Wastes Disposal Project (RAWD)
Discipline Radiological Engineering/ Environmental ***Calc. No.** 0100N-CA-V0004
Subject Dose Estimates for Workers Involved with Remediating 1301N & 1325
Computer Program MICROSHEILD **Program No.** VERSION 4

Committed Calculation **Preliminary** ☒ **Superseded** ☐

Rev.	Sheet Numbers	Originator	Checker	Reviewer	Approval	Date
0	1-18	10/10/97 MA Wesselman	10/10/97 RF Patch	10/10/97	J.W. DARBY	10-10-97 10/10/97

SUMMARY OF REVISION

Scanned:	Rev.	Date	Bar Code No.	Rev.	Date	Bar Code No.

*Obtain Calc. No. from DIS.

Originator Mike Wesselman MW Date 10/10/97 Calc. No. 100N-CA-V0004 Rev No 0
Project 100N CRIBS, RAWD Job No. 22192 Checked M Date: 10/10/97
Subject Dose Estimates for Workers Involved with Remediating 1301N & 1325N
Sheet No. 1 of 18

Dose rates for worker expected to spend time in low dose areas or more than 30 feet from B-25 boxes and drums.

This group includes all workers not directly involved with the excavation in Option 2. Laborers and RCT's at ERDF in options 3 and 5 and the water truck driver in all options.

The 1995 Man Carried Radiological Detection System (MRDS) survey (File ID #'s 1325C826.dwg & 1301C826.dwg) shows dose rates along the edge of 1301N and 1325N range from .1 to 100 mR/hr. Removing the panels, allowing 6 years for the decay of Co-60 between 1995 and 2001, and applying 2 feet of overburden is expected to reduce doses in these areas to between background and 1 mR/hour. A dose **of .1 mR/hr** is used when calculating the exposures to these workers. A value of .03 mR/hr was used for estimating exposures for workers in similar functions at the 100 BC remedial action and the estimated exposures have been higher than the recorded ones for over a year.

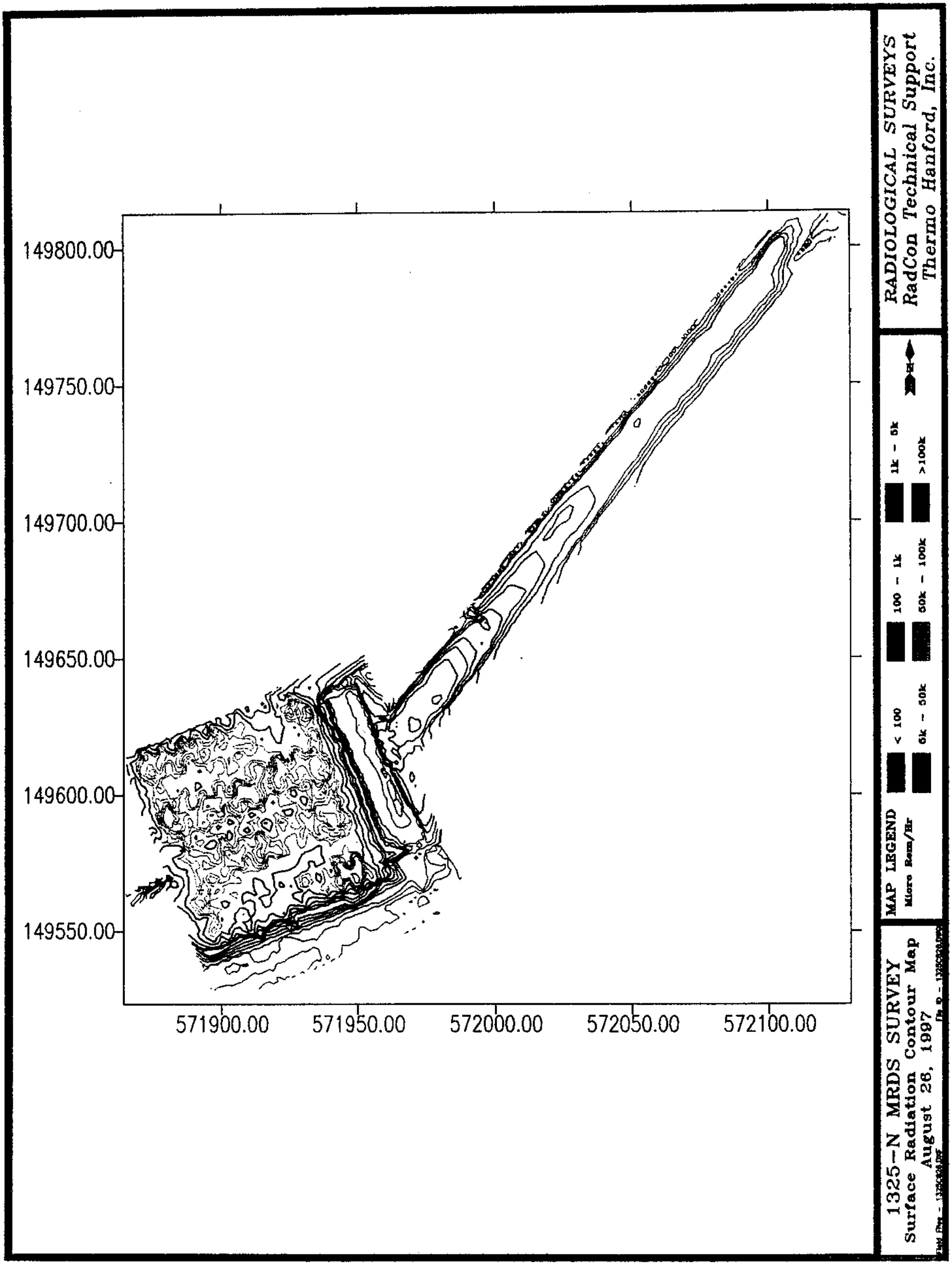
Modeling with MICROSHIELD version IV software, using sample results from 1995 drilling operations shows that 2/3 of the 1995 dose rate is from Co^{60}. By 2001 the dose rates from Co-60 will decrease by at least 55% which should decrease the total dose rate by at least 35%. Modeling shows two feet of fill over the most contaminated areas reduces the dose by at least a factor of 100 (See Microshield DOS File "TRENC5" output for Case number 1, no buildup divided by the output for case 4 , no buildup). It is assumed that this will reduce exposure in surrounding areas as well. It is further assumed low dose areas of .1 mR/hr can be created in the work area using steel plate, soils or crib panels for shielding and workers can move to even lower dose areas when working near 1325 N.

The same dose is used to represent "shine" through less contaminated overburden from high dose items and soils placed at the Environmental Restoration Disposal Facility (ERDF).

Dose to Workers with Blended Wastes.

This applies to all workers near filled containers in Option 2 and workers near filled RCI containers in options 3 & 4.

Modeling shows that the most highly contaminated soils can be shielded to near background levels if three feet of soil is between the source and the receptor (See Microshield DOS File "TRENC5" output for Case number 4, no buildup) . The "blending" operation will provide shielding to the driver and anyone in Container Storage areas by placing the medium radioactive soils in the center of the container. It is assumed that the blending technique can be modified to ensure all workers are shielded. Based on current sample data, medium contaminated soils will not occupy more than 60% of the container. Most containers will have levels below this. Dose rates consistent with current remedial actions were selected.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149700.00
149650.00
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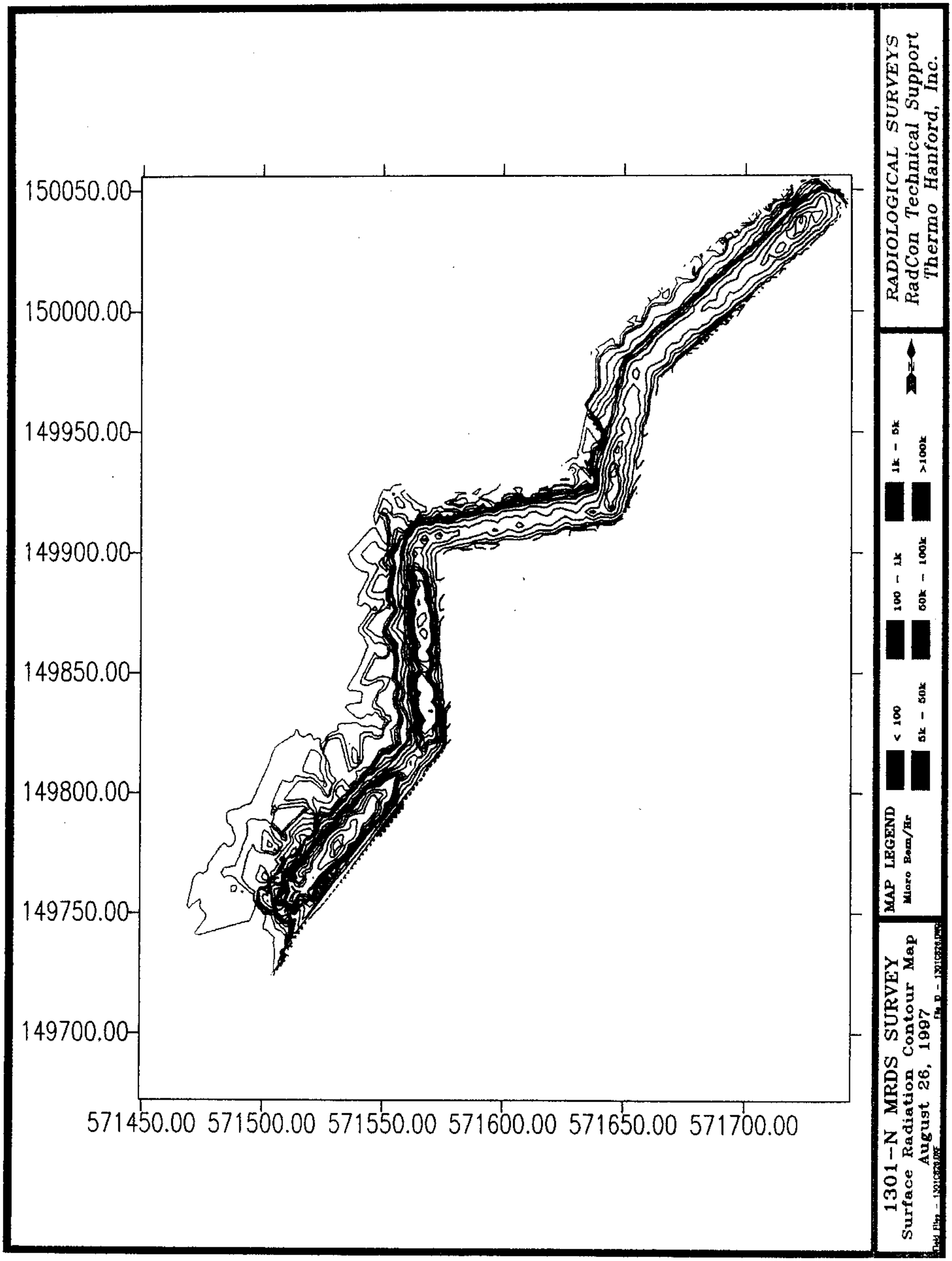
149550.00
571900.00
571950.00
572000.00
572050.00
572100.00
RADIOLOGICAL SURVEYS
RadCon Technical Support
Thermo Hanford, Inc.
MAP LEGEND
Micro Rem/Hr
< 100
100 - 1k
1k - 5k
5k - 50k
50k - 100k
>100k
1325-N MRDS SURVEY
Surface Radiation Contour Map
August 26, 1997


150050.00
150000.00
149950.00
149900.00
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149800.00
149750.00
149700.00
571450.00
571500.00
571550.00
571600.00
571650.00
571700.00
RADIOLOGICAL SURVEYS
RadCon Technical Support
Thermo Hanford, Inc.
MAP LEGEND
Micro Rem/Hr
< 100
100 - 1k
1k - 5k
5k - 50k
50k - 100k
>100k
1301-N MRDS SURVEY
Surface Radiation Contour Map
August 26, 1997

Draft A

Page : 1
DOS File: TRENC5.MS4
Run Date: September 14, 1997
Run Time: 10:39 p.m. Sunday
Duration: 0:04:17

File Ref: ________
Date: 6/18/97
By: [illegible]
Checked: ________

Case Title: model of trench +5 yrs 0-3' ovrbrden 1uC/g ea Co60, Cs137

GEOMETRY 13 - Rectangular Volume

	centimeters	feet and	inches
Dose point coordinate X:	570.0	18.0	8.4
Dose point coordinate Y:	500.0	16.0	4.9
Dose point coordinate Z:	5000.0	164.0	.5
Rectangular volume width :	10000.0	328.0	1.0
Rectangular volume length:	400.0	13.0	1.5
Rectangular volume height:	1000.0	32.0	9.7
Shield 1:	91.44	3.0	.0
Air Gap:	78.56	2.0	6.9

Source Volume: 4000000000 cm^3 141259. cu ft. 2.44095e+8 cu in.

MATERIAL DENSITIES (g/cm^3)

Material	Source Shield	Shield 1 Slab	Air Gap
Air			0.00122
Concrete	1.8	1.5	

BUILDUP
Method: Buildup Factor Tables
The material reference is Shield 1

INTEGRATION PARAMETERS

	Quadrature Order
X Direction	10
Y Direction	20
Z Direction	20

SOURCE NUCLIDES

Nuclide	curies	microCi/cm^3	Nuclide	curies	microCi/cm^3
Ba-137m	5.3974e+003	1.3493e+000	Co-60	3.3161e+003	8.2902e-001
Cs-137	5.7055e+003	1.4264e+000			

====== RESULTS FOR SENSITIVITY REFERENCE CASE (Shield #1 = 91.44) ======

Energy (MeV)	Activity (photons/sec)	Energy Fluence Rate (MeV/sq cm/sec)		Exposure Rate In Air (mR/hr)	
		No Buildup	With Buildup	No Buildup	With Buildu
0.0318	4.134e+012	2.691e-066	1.386e-022	2.242e-068	1.155e-024
0.0322	7.628e+012	4.697e-064	2.658e-022	3.780e-066	2.139e-024
0.0364	2.776e+012	1.451e-047	1.481e-022	8.244e-050	8.416e-025
0.6616	1.797e+014	2.357e-001	1.043e+001	4.569e-004	2.023e-002
0.6938	2.001e+010	3.609e-005	1.480e-003	6.969e-008	2.857e-006
1.1732	1.227e+014	6.323e+000	1.146e+002	1.130e-002	2.047e-001
1.3325	1.227e+014	1.350e+001	2.040e+002	2.342e-002	3.539e-001
TOTAL:	4.396e+014	2.006e+001	3.290e+002	3.518e-002	5.788e-001

SENSITIVITY RESULTS For: Shield #1 (cm)

Case Number	Sensitivity Variable Value	Energy Fluence Rate (MeV/sq cm/sec)		Exposure Rate In Air (mR/hr)	
		No Buildup	With Buildup	No Buildup	With Build
1	0.0	3.342e+005	7.776e+005	6.000e+002	1.403e+00
2	30.48	7.941e+003	5.134e+004	1.406e+001	9.160e+00
3	60.96	3.722e+002	4.123e+003	6.549e-001	7.294e+00
4	91.44	2.006e+001	3.290e+002	3.518e-002	5.788e-00

Use the Display Menu For Energy Group Results For All Cases.

Originator Mike Wesselman Date 10/10/97 Calc. No. 100N-CA-V0004 Rev No 0
Project 100N CRIBS, RAWD Job No. 22192 Checked Date: 10/10/97
Subject Dose Estimates for Workers Involved with Remediating 1301N & 1325N
Sheet No. 2 of 18

Dose to Track hoe & Forklift Operators.

This exposure estimate assumes a track hoe with a 30' boom arm (similar to a Caterpillar 325L excavator). The dimensions of a trackhoe bucket are assumed to be 1 meter cubed. The dose rate from the bucket will only be a minor addition to the operator's dose. The MICROSHIELD model shows by applying shielding to a trackhoe "thumb" and using a bucket with 1" thick sides, dose rates from the bucket should be less than 1 mR/hr for soils contaminated with 1 uCi/g each of Cs^{137} and Co^{60}. See MICROSHIELD DOS file "BUCET", output for case number 3, no buildup.

Dose rates from being near the edge of the exposed wastes will probably contribute the majority of the exposure. Shielding can be applied to the trackhoe to minimize this exposure. The dose rates are assumed to be the same for the forklift operator because the B-25 boxes, which are moved by the forklift, will be filled near the edge of the crib.

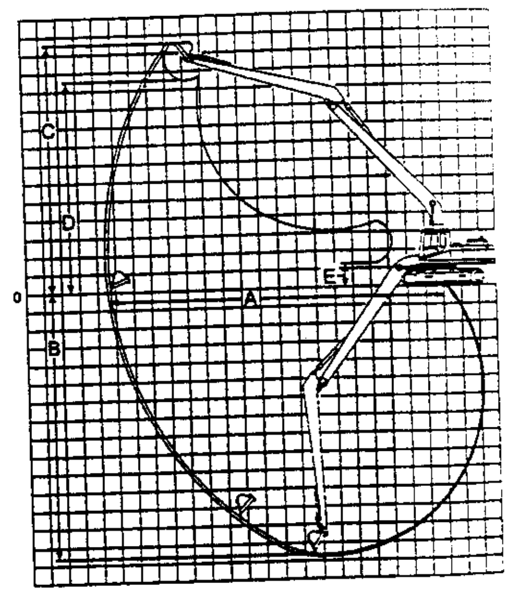
The 1995 MRDS survey (File ID #'s 1325C826.dwg & 1301C826.dwg) shows dose rates along the edge of the trenches to range from .1 to 100 mrem/hr. Removing the panels and applying 2 feet of overburden is expected to reduce dose rates in these areas to between background and 1 mR/hr. Some locations on the cribs will still have dose rates up to 10 mR/hr, but the long boom on the trackhoe should preclude the need for workers to stay in these areas. The remainder of the exposure for these workers will come from being near containers filled with wastes. The forklift will have at least 2 inches of plate steel installed on its lifting face and the driver will be approximately 10 feet away from the B-25 boxes and drums of TRU wastes. The track hoe operator should be able to stay at least 20 feet way from any container. The combination of shielding and distance should keep the average dose rate for the operators **below 3.5 mR/hr.** This dose rate allows for brief periods where the operators are exposed to the unshielded container. Modeling shows this assumption is valid.

A larger forklift was specified to accommodate the required shielding, and its costs were calculated

INTRODUCTION

Long reach excavators are designed specifically for those jobs requiring reach capability beyond the range of normal excavators. Applications for which long reach excavators are ideally suited include ditch cleaning, slope finishing, river conservation, and other work formerly reserved for draglines.

Caterpillar offers two hydraulic excavator models in long reach arrangements. Each model uses purpose-built booms and sticks designed by Caterpillar for maximized performance and durability.



320 L LONG REACH
325 L LONG REACH

Long Reach Front Includes: Boom, stick, linkage cylinders (boom, stick, and bucket), hydraulic lines, and additional counterweight for stability while working over the side. Dimensions include ditch cleaning bucket.

Model	320 L Long Reach mm	ft	320 L* Long Reach mm	ft	325 L Long Reach mm	ft
A Maximum Reach at Ground Level	15 725	51'7"	16 540	54'3"	18 290	60'0"
B Maximum Digging Depth	11 880	39'0"	12 800	42'0"	14 625	48'0"
C Maximum Cutting Height	13 290	43'7"	13 400	43'11"	13 580	44'7"
D Maximum Dumping Height	11 010	36'1"	11 350	37'3"	11 550	37'11"
E Minimum Loading Height	1970	6'6"	2300	7'6"	1347	4'5"

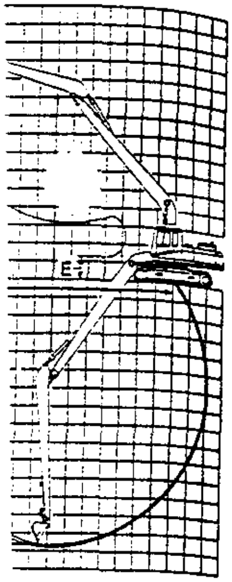
320 L, 325 L LONG REACH

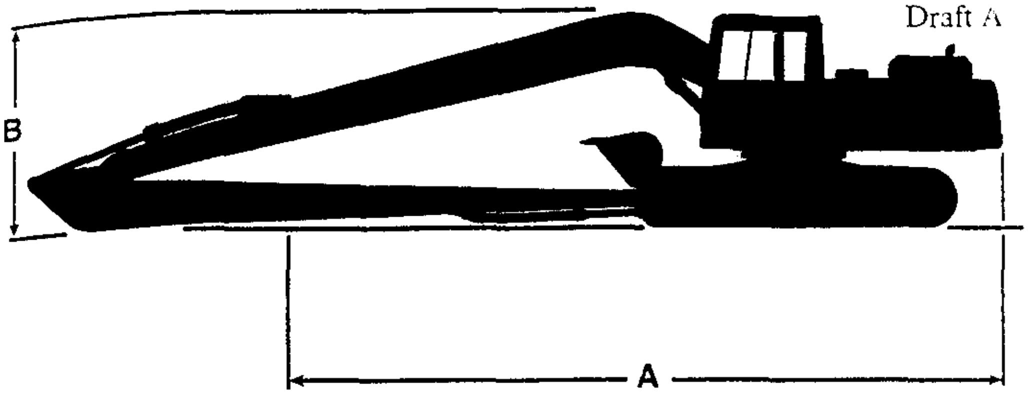
Bucket Type	Bucket Width		Tip Radius		SAE Heaped Cap.		Bucket Weight		No. of Teeth
	mm	in	mm	in	L	yd^3	kg	lb	
General Purpose	810	32	1220	48	450	0.59	340	750	5
Ditch Cleaning	1142	45	1091	43	600	0.78	290	640	None

320 L* LONG REACH

Bucket Type	Bucket Width		Tip Radius		SAE Heaped Cap.		Bucket Weight		No. of Teeth	Bucket Curl Force		Stick Crowd For	
	mm	in	mm	in	L	yd^3	kg	lb		kN	lb	kN	
General Purpose	—		—		—		—		—	—		—	
Ditch Cleaning	1800	70.8	780	30.7	600	0.78	400	882	—	63.25	14,231	62.82	[illegible]

*Belgium sourced
Note: All dimensions reflect machines equipped with ditch cleaning bucket.





325 L Long Reach mm	ft
18 290	60'0"
14 625	48'0"
13 580	44'7"
11 550	37'11"
1347	4'5"

Bucket Weight	No. of Teeth
—	5
640	None

Bucket Curl Force lb	Stick Crowd Force kN	Stick Crowd Force lb
—	—	—
14,231	62.82	14,134

LONG REACH ATTACHMENT SHIPPING DIMENSIONS

Model	320 L m	320 L ft	320 L* m	320 L* ft	325 L m	325 L ft
A Overall Transport Length (Front Folded)	12.65	41'6"	12.99	42'7"	14.37	47'2"
B Overall Height (To Top of Boom)	3.21	10'6"	3.35	10'0"	3.25	10'8"
Overall Width (To Widest Point)	3.18	10'5"	3.7	12'2"	3.39	11'1"

*Belgium sourced. Extra wide gauge and 900 mm (35") track shoes.
Note: For other base machine dimensions, see section on machines with GP attachments.

LONG REACH ATTACHMENT COMPONENT WEIGHTS

Model	320 L kg	320 L lb	320 L* kg	320 L* lb	325 L kg	325 L lb
Additional Counterweight	800	1764	1100	2425	1100	2425
Long Reach Boom: Includes boom, stick cylinder, hydraulic lines, and pins for stick, stick cylinder, and boom rod end	2270	5004	2504	5515	3110	6856
Long Reach Stick: Includes stick, bucket linkage and pins, bucket cylinder and pin, and hydraulic lines	1260	2778	1290	2841	1570	3461

*Belgium sourced. Includes extra wide gauge and reinforced upperframe.

MicroShield 4.21 - Serial #4.21-00949
Bechtel Hanford, Inc.

BHI-01092
Draft A

Page : 1
DOS File: BUCET.MS4
Run Date: September 14, 1997
Run Time: 7:58 p.m. Sunday
Duration: 0:02:31

File Ref:
Date: 10/10/97
By: M.W.
Checked: M.W.

Case Title: trachoe bucket

GEOMETRY 13 - Rectangular Volume

	centimeters	feet	and inches
Dose point coordinate X:	1100.0	36.0	1.1
Dose point coordinate Y:	50.0	1.0	7.7
Dose point coordinate Z:	0.0	0.0	.0
Rectangular volume width :	100.0	3.0	3.4
Rectangular volume length:	100.0	3.0	3.4
Rectangular volume height:	100.0	3.0	3.4
Shield 1:	900.0	29.0	6.3
Shield 2:	2.54	0.0	1.0
Air Gap:	97.46	3.0	2.4

Source Volume: 1000000 cm^3 35.3147 cu ft. 61023.7 cu in.

MATERIAL DENSITIES (g/cm^3)

Material	Source Shield	Shield 1 Slab	Shield 2 Slab	Air Gap
Air		0.00122		0.00122
Concrete	1.5			
Iron			7.86	

BUILDUP
Method: Buildup Factor Tables
The material reference is Shield 2

INTEGRATION PARAMETERS

	Quadrature Order
X Direction	10
Y Direction	20
Z Direction	20

SOURCE NUCLIDES

Nuclide	curies	microCi/cm^3	Nuclide	curies	microCi/cm^3
Ba-137m	1.4190e+000	1.4190e+000	Co-60	1.5000e+000	1.5000e+00(
Cs-137	1.5000e+000	1.5000e+000			

Change to Em

DOS File: BUCET.MS4
Run Date: September 14, 1997
Run Time: 7:58 p.m. Sunday
Title : trachoe bucket

======= RESULTS FOR SENSITIVITY REFERENCE CASE (Shield #2 = 2.54) =======

Energy (MeV)	Activity (photons/sec)	Energy Fluence Rate (MeV/sq cm/sec) No Buildup	Energy Fluence Rate (MeV/sq cm/sec) With Buildup	Exposure Rate In Air (mR/hr) No Buildup	Exposure Rate In Air (mR/hr) With Buildup
0.0318	1.087e+009	6.004e-061	2.410e-026	5.001e-063	2.007e-028
0.0322	2.005e+009	1.026e-058	4.518e-026	8.254e-061	3.636e-028
0.0364	7.298e+008	3.565e-042	1.980e-026	2.026e-044	1.125e-028
0.6616	4.724e+010	4.458e+001	1.693e+002	8.642e-002	3.282e-001
0.6938	9.053e+006	9.465e-003	3.529e-002	1.827e-005	6.814e-005
1.1732	5.550e+010	1.770e+002	5.260e+002	3.163e-001	9.400e-001
1.3325	5.550e+010	2.303e+002	6.472e+002	3.996e-001	1.123e+000
TOTAL:	1.621e+011	4.519e+002	1.343e+003	8.023e-001	2.391e+000

SENSITIVITY RESULTS For: Shield #2 (cm)

Case Number	Sensitivity Variable Value	Energy Fluence Rate (MeV/sq cm/sec) No Buildup	Energy Fluence Rate (MeV/sq cm/sec) With Buildup	Exposure Rate In Air (mR/hr) No Buildup	Exposure Rate In Air (mR/hr) With Buildup
1	0.0	1.368e+003	2.628e+003	2.441e+000	4.694e+000
2	1.27	7.847e+002	1.909e+003	1.396e+000	3.406e+000
3	2.54	4.519e+002	1.343e+003	8.023e-001	2.391e+000

Use the Display Menu For Energy Group Results For All Cases.

Workers Handling High Dose Drums and B-25 Boxes.

Modeling indicates that some of these items could read up to 790 mR/hr at one foot. Shielded over pack drums and casks similar to those used on drilling operations at 200-BP-1 in 1990-91 will be employed to keep drum dose rates **below 50 mR/hr at 12 inches.**

The casks were constructed of 36-inch diameter schedule 40 pipe centered around a 22-inch diameter piece of schedule 60 pipe with the space between the two pipes filled with grout. The drum to be filled would be placed inside the 22-inch diameter pipe with a rigging strap attached. The drum would be filled. capped and then rigged into a storage location. Highly radioactive drums were stored inside 48-inch diameter concrete culverts with concrete lids placed over the top.

Long tools may be employed while rigging B-25 Boxes to keep workers more than three feet from the box at all times. Highly radioactive boxes will require shielding similar to that used for the drums, probably constructed of plate steel. For these items rigging will be designed so that only minimal work is required near high dose items to connect, lift and disconnect the item. On the calculation sheet a dose rate of 50 mR/hr is used to reflect time spent at three feet from the container and as an ALARA goal for shielding purposes
Past work with the monoliths* for 100N basins and highly radioactive drums of soil at 200-BP-1 indicate this dose rate is achievable. Shielding and dose reduction techniques can be refined in the design phase of the remediation.

** A monolith is a grouted cylinder of highly radioactive wastes. The monoliths produced at 100N were approximately 6 feet tall and 3 feet in diameter. Dose rates on some surfaces were up to 6 R/hr.*

MicroShield 4.21 - Serial #4.21-00949
Bechtel Hanford, Inc.

Page : 1
DOS File: B25SHLD.MS4
Run Date: September 18, 1997
Run Time: 1:43 p.m. Thursday
Duration: 0:00:44

File Ref: ____
Date: 10/10/97
By: M.N.
Checked: ____

Case Title: b-25 box with 1.5 uCi/cm of co-60 & cs-137, w/shield at 10 '

GEOMETRY 13 - Rectangular Volume

	centimeters	feet	and inches
Dose point coordinate X:	487.68	16.0	.0
Dose point coordinate Y:	76.2	2.0	6.0
Dose point coordinate Z:	76.2	2.0	6.0
Rectangular volume width :	116.84	3.0	10.0
Rectangular volume length:	182.88	6.0	.0
Rectangular volume height:	119.38	3.0	11.0
Shield 1:	0.9525	0.0	.4
Shield 2:	6.0	0.0	2.4
Air Gap:	297.8475	9.0	9.3

Source Volume: 2.55088e+6 cm^3 90.0833 cu ft. 155664 cu in.

MATERIAL DENSITIES (g/cm^3)

Material	Source Shield	Shield 1 Slab	Shield 2 Slab	Air Gap
Air				0.00122
Concrete	1.6			
Iron		7.86	7.86	

BUILDUP
Method: Buildup Factor Tables
The material reference is Shield 1

INTEGRATION PARAMETERS

	Quadrature Order
X Direction	10
Y Direction	20
Z Direction	20

SOURCE NUCLIDES

Nuclide	curies	microCi/cm^3	Nuclide	curies	microCi/cm^3
Ba-137m	5.7905e+000	2.2700e+000	Co-60	6.1221e+000	2.4000e+000
Cs-137	6.1221e+000	2.4000e+000			

RESULTS

Energy (MeV)	Activity (photons/sec)	Energy Fluence Rate (MeV/sq cm/sec) No Buildup	Energy Fluence Rate (MeV/sq cm/sec) With Buildup	Exposure Rate In Air (mR/hr) No Buildup	Exposure Rate In Air (mR/hr) With Buildup
0.0318	4.436e+009	1.030e-161	7.156e-025	8.578e-164	5.961e-027
0.0322	8.184e+009	4.281e-156	1.342e-024	3.446e-158	1.080e-026
0.0364	2.978e+009	2.584e-110	5.880e-025	1.468e-112	3.341e-027
0.6616	1.928e+011	7.612e+001	5.799e+002	1.476e-001	1.124e+000
0.6938	3.695e+007	1.708e-002	1.263e-001	3.298e-005	2.438e-004
1.1732	2.265e+011	5.531e+002	2.823e+003	9.884e-001	5.045e+000
1.3325	2.265e+011	8.079e+002	3.766e+003	1.402e+000	6.533e+000
TOTAL:	6.615e+011	1.437e+003	7.169e+003	2.538e+000	1.270e+001

MicroShield 4.21 - Serial #4.21-00949
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Page	: 1	File Ref:	
DOS File:	NCRIB25.MS4	Date:	12/12/97
Run Date:	September 18, 1997	By:	[illegible]
Run Time:	1:32 p.m. Thursday	Checked:	
Duration:	0:02:49		

Case Title: b-25 box with 1.5 uCi/cm of co-60 & cs-137, dose at 1-9'

GEOMETRY 13 - Rectangular Volume

	centimeters	feet	and inches
Dose point coordinate X:	460.248	15.0	1.2
Dose point coordinate Y:	76.2	2.0	6.0
Dose point coordinate Z:	76.2	2.0	6.0
Rectangular volume width :	116.84	3.0	10.0
Rectangular volume length:	182.88	6.0	.0
Rectangular volume height:	119.38	3.0	11.0
Shield 1:	0.9525	0.0	.4
Air Gap:	276.4155	9.0	.8

Source Volume: 2.55088e+6 cm^3 90.0833 cu ft. 155664 cu in.

MATERIAL DENSITIES (g/cm^3)

Material	Source Shield	Shield 1 Slab	Air Gap
Air			0.00122
Concrete	1.6		
Iron		7.86	

BUILDUP
Method: Buildup Factor Tables
The material reference is Shield 1

INTEGRATION PARAMETERS

	Quadrature Order
X Direction	10
Y Direction	20
Z Direction	20

SOURCE NUCLIDES

Nuclide	curies	microCi/cm^3	Nuclide	curies	microCi/cm^3
Ba-137m	5.7905e+000	2.2700e+000	Co-60	6.1221e+000	2.4000e+000
Cs-137	6.1221e+000	2.4000e+000			

Page : 2
DOS File: NCRIB25.MS4
Run Date: September 18, 1997
Run Time: 1:32 p.m. Thursday
Title : b-25 box with 1.5 uCi/cm of co-60 & cs-137, dose at 1-9'

========= RESULTS FOR SENSITIVITY REFERENCE CASE (X = 460.248) ==========

Energy (MeV)	Activity (photons/sec)	Energy Fluence Rate (MeV/sq cm/sec)		Exposure Rate In Air (mR/hr)	
		No Buildup	With Buildup	No Buildup	With Buildup
0.0318	4.436e+009	7.743e-024	9.349e-024	6.449e-026	7.787e-026
0.0322	8.184e+009	8.730e-023	9.845e-023	7.026e-025	7.923e-025
0.0364	2.978e+009	1.982e-016	2.291e-016	1.126e-018	1.302e-018
0.6616	1.928e+011	2.940e+003	7.595e+003	5.699e+000	1.472e+001
0.6938	3.695e+007	6.108e-001	1.559e+000	1.179e-003	3.011e-003
1.1732	2.265e+011	9.132e+003	2.019e+004	1.632e+001	3.609e+001
1.3325	2.265e+011	1.133e+004	2.416e+004	1.965e+001	4.192e+001
TOTAL:	6.615e+011	2.340e+004	5.195e+004	4.167e+001	9.273e+001

SENSITIVITY RESULTS For: X (cm)

Case Number	Sensitivity Variable Value	Energy Fluence Rate (MeV/sq cm/sec)		Exposure Rate In Air (mR/hr)	
		No Buildup	With Buildup	No Buildup	With Buildup
1	213.36	3.872e+005	8.923e+005	6.891e+002	1.593e+003
2	336.804	6.571e+004	1.442e+005	1.170e+002	2.575e+002
3	460.248	2.340e+004	5.195e+004	4.167e+001	9.273e+001

Use the Display Menu For Energy Group Results For All Cases.

Exposures for Drivers

Modeling shows that dose rates on the sides of B-25 boxes will be similar to dose rates on the sides of RCI containers. Modeling also shows that dose rates decrease more quickly with distance from a B-25 box than from a RCI container because B-25 boxes are smaller sources. If three B-25 boxes were placed on a flatbed, the radiation emitted by them would be similar to that emitted by one RCI container. It is assumed that fifty B-25 boxes of the most highly contaminated waste would be shipped one container at a time to allow enough shielding and distance between the driver and the box to maintain dose rates ALARA. This assumption is added to the cost of 1301-N crib. which is considered most likely to have wastes with high dose rates .

A conservative estimate for the dose to a driver is calculated by the MICROSHIELD DOS file "B25SHLD", which shows a driver can be exposed to 2.54 mR/hr when sitting in a shielded cab. The dose to the driver during brief periods outside the cab can be obtained from MICROSHIELD DOS file " NCRBB25" which calculates a dose of 41.7 mR/hr for a person 9 feet from an unshielded B-25 box.

Assuming the driver spends 25 minutes to drive between 100N and ERDF. 45 seconds within 9 feet of the truck while entering data at the ERDF scales and another 10 minutes in the cab as the B-25 boxes are off loaded. the average dose would be as follows:

(35 mins/35.66mins) x 2.54 mR/hr + (.66mins/35.66mins) 41.7mR/hr = 3.26 mR/hr

The value was rounded-up to 3.5 mrem/hr to allow for time for incidental activities outside of the shielded cab. This value is higher than that used in the "100NR-1 Treatment, Storage, and Disposal Units Corrective Measures Study (CMS) /Closure Plan" (DOE/rl-96-39) for work in 2001. There is no blending of the wastes put in the B-25 boxes and the CMS assumed a blend ratio of five to one.

Waste Labeling and Container Storage

Dose reduction for storage and labeling operations relies on quick entry and fast work at a distance.

Workers are expected to spend about 5% of their time near items reading 50 mR/hr in options 3, 4 & 5. The rest of the time will be spent in areas at or near background. In option 2 workers will spend all time in low dose areas.

Average dose rate in Options 3-5: .05 x 50 mR/hr = 2.5 mR/hr average dose rate

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N-Cribs Alternatives Study, Time Frame by Case

Operation	Case 2 (days)	Case 3 (days)	Case 4 (days)	Case 5 (days)
Remove Panels and Beams	43.9	43.9	43.9	43.9
Remove Concrete	14.5	14.5	14.5	14.5
Remove LLW soil above Boulders	14.6	14.6	14.6	14.6
Remove Boulders	40.7	47.5	47.5	47.5
Remove High Dose Soils 1301	112.9	14.8	14.8	14.8
Remove Medium Dose Soils 1301	100.8	100.8	100.8	115.5
Remove High Dose Soils 1325	113.8	43.9	43.9	43.9
Remove Medium Dose soils 1325	88.1	88.1	88.1	106.2
Total:	529.3	368.1	368.1	400.9

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Panel Removal Exposure Times

Panels removed in all options. table below contains all assumptions and estimates. Exposure rates based on the 1995 Man Carried Radiological Detection System (MRDS) survey (File ID #'s 1325C826.dwg & 1301C826.dwg)

Panel Removal Exposure Estimates

Panels removed in all options. Table contains all estimates.

Task	Crew	Hours Duration	Average Dose rate mR/hr	Dose(mrem/task)	dose/crew member
Install rigging on panels	2	120	10	2400	1200
Riggers for lift	2	285	2.5	1425	712.5
Crane operator	1	285	1	285	285
Truck driver	1	385	0.3	115.5	115.5
Install straps on beams	1	100	10	1000	1000
Dust suppression	1	385	1	385	385
Total				**5611**	

Option 1 Exposure Times

Option one was dropped from consideration by the project because it was undesirable.

Option 2 Exposure Times

Case 2	**Total Time**	529.3 Days	
	Remove Boulders		- 40.7 Days
	Remove Concrete		- 14.5 Days
	Remove Panels		- 43.9 Days
	Remaining Days		430.2 Days

Install Liners
2 hrs/day x 430 days = **860 hours.**

Liners are installed near stockpile of wastes used for blending. Dose rates near this pile should be **.1 mR/hr**. This will account for other work in elevated background even if liners installed in background area.

Boulder Forklift. (See Remove Boulders above)

40.7 days X 3.5 hrs/day = **133 hours.**

Dose rate will be **3.5 mR/hr**

Stockpile Track hoe

High dose only	High dose 1301	112.9 days
	High dose 1325	113.8 days
		226.7 days
Operator exposed 40 minutes a day.		x .66 hrs/day
		149.6hrs ≅ **150 hrs**

Operator will take about one minute to cover highly contaminated wastes. Exposure rate will average **1 mR/hr** during this operation. Based on Operator being 30 feet from one cubic meter of high level wastes.

Water Truck. see "Total Time" above.

Operator is in area 3.0 hours/day every day.
Total days = 529.3 x 3.0 hrs/day = 1587.9
≅ **1588 hours.**

Dose rate will be **.1 mR/hr.**

Excavation Track hoe

Operator will be near edge for 3.0 hrs/day every day.
Also **1588 hours.**

Dose rate will be **3.5 mR/hr**

Excavation Truck Driver

Will require more time in area since must stop at two trackhoes for half of week.
Should average 3 hrs/day in area = **1588 hours**
Should spend 50% of time in elevated dose area and 50% of time in low dose area.
Average dose rate will be .5(3.5 mR/hr) + .5(.1mR/hr) = **1.8 mR/hr**

RCT's at 100-N

Will either be near excavation or surveying containers. With proper rotation, an average low dose rate can be used but exposure time is 6.5 hrs/day.
6.5 hrs/day x 529.3 days = **3,441 hours.**

Dose rate will average **.1mR/hr.**

Laborer -will have similar duties, securing B-25s, sealing RCI containers.
Also, **3,441 hours** exposure time.

Dose rate will average **.1 mR/hr**

Waste Labeling - Approximately 40 minutes a day to apply shipping papers.
529.3 days x .66 hrs/day = 349.34 hrs ≅ **350 hours.**

Dose rate will average **.1 mR/hr**

RCI Drivers 3 hours per day x 529.3 days = 1587.9 hours ≅ 1588 **hrs.**
Most waste will be low dose.
Haul Concrete and Boulders (40.7 + 14.5 days)/ 529.3 days x 100% = 10.4 % of time
Average dose = .104 (3.5 mR/hr) + .896 (.1 mR/hr) = .454 mR/hr ≅ .5 **mR/hr**

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ERDF RCT's - 3 hours a day x total days
3 hrs/day x 529.3 days = **1587.9 ≅ 1588 hours**
Dose rate will be **.1 mR/hr**

ERDF Dozer Same as RCT's.

ERDF Riggers should spend less than 15 mins/day near high dose rate boulder boxes.
40 x .25 = **10 hours**
Dose rate will be **50 mR/hr**

ERDF Crane.
3.5 hrs/day x 40 days = **140 hours**
Operator will spend 50% of time near high dose rate waste and 50% of time at more than 30 feet from wastes.
Average dose will be .5(3.5mR/hr) + .5(.1 mR/hr) = **1.8 mR/hr**

ERDF laborers Crew will rotate on high dose work.
Exposure time will be at dump phase of low level (see calculation for installing liner) waste.

1.5 minutes/container x 40 containers/day = 1 hr/day x 430.2days = **430.2 hours.**

Dose rate will be .1 **mR/hr**

ERDF Compaction Test. Worker can minimize time on wastes, still receives dose from " shine through overburden. One test a day on loose soils
430.2 days x 7 min/test x 1 hr/60min = **50.2 hours testing**
Dose rate will be .1 mR/hr

ERDF Storage -
Worker will spend about 5 minutes a day inspecting container storage area.
529.3 days x 5 min/day x 1hr/60min = **44.1 hrs** . Dose rate will average **.1 mR/hr**

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Option 2 Exposure Estimates

Task	Crew	Hours Duration	Average Dose rate mR/hr	Dose(mrem/task)	dose/crew member
Boulder Forklift	1	133	3.5	465.5	465.5
Stockpile Track hoe	1	150	1	150	150
Liner Install	2	860	0.1	172	86
Water Truck	1	1,588	0.1	158.8	158.8
Excavation Track hoe	1	1,588	3.5	5558	5558
N Truck Driver	2	1,588	1.8	5716.8	2858.4
NRCTS	4	3,441	0.1	1376.4	344.1
Laborers	2	3,441	0.1	688.2	344.1
Waste Label	1	350	0.1	35	35
				0	0
RCI Drivers	4	1588	0.5	3176	794
ERDF RCTS	4	1588	0.1	635.2	158.8
ERDF DOZER	1	1588	0.1	158.8	158.8
Riggers (B-25's)	1	10	50	500	500
ERDF Crane	1	140	1.8	252	252
ERDF Laborers	2	430.2	0.1	86.04	43.02
Compaction Test	1	50.2	0.1	5.02	5.02
Panels & Beams				5610	0
Storage	1	44.1	0.1	4.41	4.41
Total				**24748 mrem**	

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Option 3 Exposure Time Estimates

Forklift Operator for Boulders and Hot Fill

Remove boulders	40.7 days x 3 hrs/day	= 122.1 hrs
High Dose 1301	112.9 days x 3 hrs/day	= 338.7 hrs
High Dose 1327	113.8 days x 3 hrs/day	= 341.4 hrs
TOTAL	267.5 days x 3 hrs/day	= **802.2 hrs**

Dose rate will be 3.5 mR/hr

B-25 Truck Drivers each spend half as much time as forklift operator = **401.1**
Dose rate will be **3.5 mR/hr**

Water Truck = 368.1 days x 3 hr/day = **1104 hrs.** Dose rate will be **.1 mR/hr**

Track hoe - stays behind shield half the time plus dose averages down at 1325.
368.1 days x 3 hr/day = **1104 hrs.** Dose rate will be **3.5 mR/hr**

Truck Drivers for RCI containers - only for medium dose (MD)
MD 1301 = 100.8 days x 1.5 hr/day = 151.2 hrs.
MD 1325 = 113.8 days x 1.5 hr/day = 170.7 hrs.

214.6 days x 1.5 hr/day = **321.9 hrs.**

Dose rate will be **.1 mR/hr**

RCT's at 100N Cribs - will stay in low dose or behind shielding, will work near excavation 10% time, survey out containers, and 90% time for entire project.
368.1 days x 3 hr/day = **1104 hrs.**

Will spend 10% of time near high dose rate wastes and 90% of time in low dose areas.
Average dose will be .1 (3.5mR/hr) + .9 (.1 mR/hr) = **.44mR/hr**

Laborers at 100N Cribs - same as RCTs ,**1104** hrs.
Duties will be in same areas as RCT's. Average dose rate will be **.44 mR/hr**

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Waste Labeling - Total time minus time to remove panels. Panels will have no dose rates.
368.1 days - 43.9 days = 324 days
Time near high dose items will be 5% of total time.
3.5 hrs/day x 60 min/hr x 5% of time = 10.5 min ≅ .175 hrs.
324 days x .175 hrs/day = **56.7 hrs.**
Dose will average **2.5 mR/hr**

RCI Drivers - lower level wastes only

Total	**368.1 days**
-High dose 1325	-113.8 days
-High dose 1301	-100.8 days
-High dose boulders	-40.7 days
	112.8 days
- Concrete	- 14.5 days
	98.3 days ≅ 99 days
	X 3.25 hr/day
	321.75 hrs

Dose rate will be **.1 mR/hr.**

RCI B-25 Approximately 8600 boxes hauled 3 at a time = 2867 trips ÷ 4 drivers = 717 trips/driver
Driver is in dose for 30 min/trip = **358.5 hours**
Dose rate will be **3.5 mR/hr**

ERDF RCT's and Dozer Majority of time in low dose areas.
Average dose will be = **.1mR/hr**

Crane operator - is exposed for about 5 minutes per box for 8600 boxes
8600 x .083 = 713.8 hrs.
Operator will spend 50% of time near high dose rate waste and 50% of time at more than 30 feet from wastes.
Average dose will be .5(3.5mR/hr) + .5(.1 mR/hr) = **1.8 mR/hr**

ERDF Riggers - are exposed about the same amount of time as the crane operator is
= 718.3 hours

Average dose rate will be similar to that for waste labeling **2.5 mR/hr**

ERDF Laborers - same as RCTs – **1104 hrs, .1 mR/hr**

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Compaction Testing - Will not be exposed to B-25 boxes.
368.1 days x 7min/test x 1 hr/60min = 42.94 hrs ≅ **43 hrs.**
Dose rate will be **.1 mR/hr**

ERDF Storage -
Worker will spend about 5 minutes a day inspecting container storage area.
368.1 days x 5 min/day x 1hr/60min = 30.67 hrs ≅ **31 hrs**
Average dose rate will be **2.5 mR/hr**

Option 3 Exposure Estimates

Task	Crew	Hours Duration	Average Dose rate mR/hr	Dose(mrem/task)	dose/crew member
B25 forklift	1	802.2	3.5	2807.7	2807.7
B25 truck	2	401.1	3.5	2807.7	1403.85
Water truck	1	1104	0.1	110.4	110.4
Track hoe	1	1104	3.5	3864	3864
N truck driver	2	321.9	0.1	64.38	32.19
NRCTS	4	1104	0.44	1943.04	485.76
Laborers	4	1104	0.44	1943.04	485.76
Waste labeling	1	56.7	2.5	141.75	141.75
RCI Drivers	4	321.75	0.1	128.7	32.175
RCI B25 drivers	4	358.5	3.5	5019	1254.75
ERDF RCTS	4	1104	0.1	441.6	110.4
ERDFDOZER	1	1104	0.1	110.4	110.4
crane operator	1	713.8	1.8	1284.84	1284.84
ERDF Riggers	1	713.8	2.5	1784.5	1784.5
ERDF Laborers	2	1104	0.1	220.8	110.4
Compaction test	1	53.65	0.1	5.365	5.365
Storage	1	31	2.5	77.5	77.5
Panels & Beams				5610	
Total				**28365 mrem**	

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MW.

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Option 4 Worker Exposure Time Estimates

Same as Option 3, except there is no compaction test and no bulldozer at waste management. Did not account for additional time that may be required to package, label and document waste to waste management's specifications.

Option 4 Worker Exposure Estimates

Task	Crew	Hours Duration	Average Dose rate mR/hr	Dose(mrem/task)	dose/crew member
B25 Forklift	1	802.2	3.5	2807.7	2807.7
B25 Truck	2	401.1	3.5	2807.7	1403.85
Water Truck	1	1104	0.1	110.4	110.4
Track hoe	1	1104	3.5	3864	3864
N Truck Driver	2	321.9	0.1	64.38	32.19
NRCTS	4	1104	0.44	1943.04	485.76
Waste Label	1	56.7	2.5	141.75	141.75
Laborers	4	1104	0.44	1943.04	485.76
RCI Drivers	4	321.75	0.1	128.7	32.175
RCI B25 Drivers	4	358.5	3.5	5019	1254.75
WM HPT's	4	1104	0.1	441.6	110.4
Crane Operator	1	713.8	1.8	1284.84	1284.84
WM Riggers	1	713.8	2.5	1784.5	1784.5
WM Burial	2	1104	0.1	220.8	110.4
Storage	1	31	2.5	77.5	77.5
Panels & Beams				5610	
Total				**28249 mrem**	

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Option 5 Exposure Times

Forklift for B-25 present for all but panel a concrete beam removal therefore
400.9 days
- 14.6 days
- 14.5 days
- 43.9 days
327.9 days at 3/hr/day = **983.7 hours**
Dose rate will average **3.5 mR/hr.**

B-25 Truck exposed ½ as much as forklift.
983.7 hrs ÷ 2 = 491.85 hrs = **492 hours**.
Dose rate will average **3.5 mR/hr**

Water Truck - 3 hr/day x 400 days = **1200 hours**
Dose rate will average **.1 mR/hr**

Track hoe same as forklift = **983.7 hours**
Dose rate will average **3.5 mR/hr**

N Truck Driver - ½ as much as forklift = **492 hours**
Half of boxed wastes will be medium and low dose wastes in this option
Dose rate will average **1.8 mR/hr**

RCT's-will use shielding and distance but still exposures will be higher. **983.7 hours**
RCT will spend 50% of time near high dose rate waste and 50% of time in low dose areas.
Average dose will be .5(3.5mR/hr) + .5(.1 mR/hr) = **1.8 mR/hr**

N Laborers - will assist securing loads and with surveys and packaging. Will average about ½ workday near wastes.
327.9 days x 3.0 hr/day = **983.7**
Average dose rate will also be **1.8 mR/hr.**

Waste labeling will be limited to 15 min/day . 400 days x .25 hr/day = **100 hours**
Dose rate will average **2.5 mR/hr**

RCI Drivers - exposed ½ as much as 100N Drivers = **245 hours**
Half of boxed wastes will be medium and low dose wastes in this option.
Dose rate will average **1.8 mR/hr**

ERDF RCT's will be exposed slightly more than in a typical low dose situation because of surveys performed on B-25 boxes. = 492 **hours**
Dose rate will average **.44 mR/hr**

Bechtel Hanford, Inc. CALCULATION SHEET

Originator Mike Wesselman M.W. Date 10/10/97 Calc. No. 100N-CA-V0004 Rev No 0
Project 100N CRIBS,RAWD Job No. 22192 Checked H Date 10/10/97
Subject Dose Estimates for Workers Involved with Remediating 1301N & 1325N
Sheet No. 16 of 18

ERDF Riggers same as B-25 truck drivers at 100N = **492 hours**
Dose rate will average **2.5 mR/hr**

Storage – 400 days x 5 min/day x 1 hr/60 min = **33.3 hrs.**
Dose rate will average **2.5 mR/hr**

Option 5 Exposure Estimates

Task	Crew	Hours Duration	Average Dose rate mR/hr	Dose(mrem/task)	dose/crew member
B25 Forklift	1	983.7	3.5	3442.95	3442.95
B25 Truck	2	492	3.5	3444	1722
Water Truck	1	1200	0.1	120	120
Track hoe	1	983.7	3.5	3442.95	3442.95
N truck driver	2	492	1.8	1771.2	1771.2
NRCTS	4	983.7	1.8	7082.64	1770.66
Laborers	4	983.7	1.8	7082.64	1770.66
Waste Label	1	100	2.5	250	250
RCI B25 drivers	4	245	1.8	1764	441
ERDF RCTS	4	492	0.44	865.92	216.48
ERDF Riggers	1	492	2.5	1230	1230
ERDF Crane	1	492	0.1	49.2	49.2
Storage	4	100	2.5	1000	250
Panels & Beams				5610	0
Total				**37156 mrem**	

Bechtel Hanford, Inc. CALCULATION SHEET

Originator Mike Wesselman M.W. Date 10/10/97 Calc. No. 100N-CA-V0004 Rev No 0
Project 100N CRIBS,RAWD Job No. 22192 Checked W Date 10/10/97
Subject Dose Estimates for Workers Involved with Remediating 1301N & 1325N
Sheet No. 17 of 18

TRU-Drum Exposure Times

Drum handler: 20 drums/hour for 1000 drums = **50 hours**
Dose rate will be **50 mR/hr**
Forklift: Handles drum 3 times, during fill, during lidding and during loading.
150 hours with drum on board
150 hours empty
25 hours stand-by = **325 hours**
Dose rate will be **3.5 mR/hr**
Track hoe can only go as fast as forklift = **325 hours**
Dose will be **3.5 mR/hr**
N Truck Driver - same = **325 hours**
Dose rate will be **3.5 Mr/hr**
RCTs = **325 hours,** Dose rate will be **.44 mR/hr**

Laborers = **325 hours,** Dose rate will be **.44mR/hr**

Waste label 15 min/day for 48 days = **12 hours,** Dose rate will be **2.5 mR/hr.**

RCI Drivers - 2 hr/day for 48 days = 96 , or ~ **100 hours,** Dose rate will be **3.5 mR/hr**

Waste Management (WM) HPT's – will need to stand by for about 1/3 of transport time, **30 hours.** Dose rate will be same as for RCT's **.44 mR/hr**

WM Riggers - will take a little more than ½ as long to unload as to load. **175 hours**
Dose rate will average **2.5 mR/hr**

WM Crane- Same duration as riggers, **175 hours.** Dose rate will be, **.1 mR/hr**

Receipt Inspection for TRU- similar to HPT duties. **30 hours,** Dose rate will be **.1 mR/hr**

Wastes storage- TRU is not buried, waste will be inspected about **12 hours a year.**
Dose rate will be **.1 mR/hr**

Bechtel Hanford, Inc. CALCULATION SHEET

Originator Mike Wesselman MW Date 10/10/97 Calc. No. 100N-CA-V0004 Rev No 0
Project 100N CRIBS,RAWD Job No. 22192 Checked H Date 10/10/97
Subject Dose Estimates for Workers Involved with Remediating 1301N & 1325N
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TRU- Drum Dose Estimate

Task	Crew	Hours Duration	Average Dose rate mR/hr	Dose(mrem/task)	dose/crew member
Drum Handling	1	50	50	2500	2500
Forklift	1	325	3.5	1137.5	1137.5
Track hoe	1	325	3.5	1137.5	1137.5
N Truck driver	2	325	3.5	2275	1137.5
NRCTS	4	325	0.44	572	143
Laborers	2	325	0.44	286	143
Waste Label	1	12	2.5	30	30
RCI drivers	4	100	3.5	1400	350
WM HPT's	1	30	0.44	13.2	13.2
WM Crane	1	175	0.1	17.5	17.5
WM Riggers	1	175	2.5	437.5	437.5
WM Receiving	1	30	0.1	3	3
Storage	1	12	2.5	30	30
Total				**9879**	**mrem**

APPENDIX D

REMEDIATION OPTION COST SUMMARY

Table D-1. Option 2.

Item	Item Description	Equipment $	Materials $	Labor $	S/C $	Subtotal Direct	Distribs 25%	Home Office 3.00%	Profit 5.00%	B&O Tax 0.47%		Total Bid $
	Remove Panels & Beams	$ 33,230	$ 62,490	$ 239,382	$ 49,530	$ 384,632	$ 96,158	$ 14,424	$ 24,761	$ 2,444	$ -	$ 522,418
	Remove High Dose Concrete	$ 2,657	$ 78,180	$ 2,738	$ 585	$ 84,160	$ 21,040	$ 3,156	$ 5,418	$ 535	$ -	$ 114,309
	Remove LLW Concrete	$ 16,994	$ 534	$ 10,593	$ -	$ 28,121	$ 7,030	$ 1,055	$ 1,810	$ 179	$ -	$ 38,195
	Remove LLW Soil above Boulders	$ 12,392	$ 16,602	$ 12,223	$ -	$ 41,217	$ 10,304	$ 1,546	$ 2,653	$ 262	$ -	$ 55,982
	Remove Boulders 1301 Crib	$ 45,489	$ 3,248,223	$ 61,098	$ 8,385	$ 3,363,195	$ 840,799	$ 126,120	$ 216,506	$ 21,369	$ -	$ 4,567,988
	High Dose Soil 1301 Crib & Trench	$ 290,499	$ 232,068	$ 262,995	$ 150,106	$ 935,669	$ 233,917	$ 35,088	$ 60,234	$ 5,945	$ -	$ 1,270,852
	High Dose Soil 1325 Crib & Trench	$ 291,548	$ 234,463	$ 266,963	$ 147,324	$ 940,298	$ 235,075	$ 35,261	$ 60,532	$ 5,974	$ -	$ 1,277,140
	Medium Dose Soil 1301 Crib & Trench	$ 176,165	$ 122,709	$ 159,755	$ 6,565	$ 465,194	$ 116,299	$ 17,445	$ 29,947	$ 2,956	$ -	$ 631,841
	Medium Dose Soil 1325 Crib & Trench	$ 155,756	$ 107,233	$ 140,956	$ 5,785	$ 409,730	$ 102,433	$ 15,365	$ 26,376	$ 2,603	$ -	$ 556,508
	Excavate Clean Overburden 1301	$ 13,866	$ -	$ 7,920	$ -	$ 21,786	$ 5,447	$ 817	$ 1,402	$ 138	$ -	$ 29,590
	Excavate Clean Overburden 1325	$ 6,941	$ -	$ 3,966	$ -	$ 10,907	$ 2,727	$ 409	$ 702	$ 69	$ -	$ 14,814
	Support Functions	$ 17,488	$ 201,486	$ 1,529,808	$ -	$ 1,748,782	$ 437,195	$ 65,579	$ 112,578	$ 11,111	$ -	$ 2,375,246
	Mobilization/Demobilization	$ 26,404	$ 248,912	$ 4,805	$ 118,000	$ 398,121	$ 99,530	$ 14,930	$ 25,629	$ 2,530	$ -	$ 540,739
	Subtotals:	$ 1,089,431	$ 4,552,900	$ 2,703,202	$ 486,280	$ 8,831,813	$ 2,207,953	$ 331,193	$ 568,548	$ 56,116	$ -	$ 11,995,622
	ERDF Disposal	$ 192,946	$ -	$ -	$ 17,269,694	$ 17,462,641						$ 17,462,641
	ERC Support	$ -	$ -	$ 2,045,615	$ 500,000	$ 2,545,615						$ 2,545,615
										Subtotal		$ 32,003,878
	Option 2 Blend lower dose materials (LLW from 100 H & F) with materials from 1301 Crib & Trench and 1325 Crib & Trench to lower dose rate								Direct Distribs @ 18.49%			$ 5,917,517
	to allow free dumping at ERDF with modified operations at ERDF.											
	High dose soil (top 1 foot) blended at 25 :1. Assume blended with 2 feet of shielding on top and the LLW materials.									Subtotal		$ 37,921,395
	Medium dose soil (next 4 feet) blended at 1.2:1 . Assume blended with 1 foot of shielding on top and 3.8 feet of											
	material beneath the Medium dose layer.								G&A @ 3.89%			$ 1,475,142
										TOTAL:		$ 39,396,538

Table D-2. Option 3.

Item	Item Description	Equipment	Materials	Labor	S/C	Subtotal	Distribs	Home Office	Profit	B&O Tax		Total
		$	$	$	$	Direct	25%	3.00%	5.00%	0.47%		Bid
												$
	Remove Panels & Beams	$ 33,230	$ 62,490	$ 239,382	$ 49,530	$ 384,632	$ 96,158	$ 14,424	$ 24,761	$ 2,444	$ -	$ 522,418
	Remove High Dose Concrete	$ 2,657	$ 78,180	$ 2,738	$ 585	$ 84,160	$ 21,040	$ 3,156	$ 5,418	$ 535	$ -	$ 114,309
	Remove LLW Concrete	$ 16,994	$ 534	$ 10,593	$ -	$ 28,121	$ 7,030	$ 1,055	$ 1,810	$ 179	$ -	$ 38,195
	Remove LLW soil above Boulders	$ 12,392	$ 16,602	$ 12,223	$ -	$ 41,217	$ 10,304	$ 1,546	$ 2,653	$ 262	$ -	$ 55,982
	Remove Boulders 1301 Crib	$ 53,069	$ 3,789,035	$ 71,265	$ 9,360	$ 3,922,729	$ 980,682	$ 147,102	$ 252,526	$ 24,924	$ -	$ 5,327,964
	High Dose Soil 1301 Crib & Trench	$ 18,001	$ 1,181,852	$ 23,101	$ 2,925	$ 1,225,880	$ 306,470	$ 45,970	$ 78,916	$ 7,789	$ -	$ 1,665,025
	High Dose Soil 1325 Crib & Trench	$ 56,929	$ 3,505,780	$ 71,508	$ 8,580	$ 3,642,797	$ 910,699	$ 136,605	$ 234,505	$ 23,146	$ -	$ 4,947,751
	Medium Dose Soil 1301 Crib & Trench	$ 176,165	$ 122,709	$ 159,755	$ 6,565	$ 465,194	$ 116,299	$ 17,445	$ 29,947	$ 2,956	$ -	$ 631,841
	Medium Dose Soil 1325 Crib & Trench	$ 155,756	$ 107,233	$ 140,956	$ 5,785	$ 409,730	$ 102,433	$ 15,365	$ 26,376	$ 2,603	$ -	$ 556,508
	Excavate Clean Overburden 1301	$ 13,866	$ -	$ 7,920	$ -	$ 21,786	$ 5,447	$ 817	$ 1,402	$ 138	$ -	$ 29,590
	Excavate Clean Overburden 1325	$ 6,941	$ -	$ 3,966	$ -	$ 10,907	$ 2,727	$ 409	$ 702	$ 69	$ -	$ 14,814
	Support Functions	$ 12,162	$ 120,863	$ 945,715	$ -	$ 1,078,740	$ 269,685	$ 40,453	$ 69,444	$ 6,854	$ -	$ 1,465,176
	Mobilization/Demobilization	$ 23,125	$ 246,447	$ 4,565	$ 118,000	$ 392,136	$ 98,034	$ 14,705	$ 25,244	$ 2,492	$ -	$ 532,611
	Subtotals:	$ 581,287	$ 9,231,726	$1,693,688	$ 201,330	$ 11,708,030	$ 2,927,008	$ 439,051	$ 753,704	$ 74,391	$ -	$ 15,902,184
	ERDF Disposal	$ 457,496	$ -	$ -	$ 8,369,833	$ 8,827,329						$ 8,827,329
	ERC Support	$ -	$ -	$1,422,617	$ 500,000	$ 1,922,617						$ 1,922,617
										Subtotal		$ 26,652,129
	Option 3 Containerized shipments of High dose materials to ERDF with blending of Medium dose materials for free dumping								Direct Distribs @ 18.49%			$ 4,927,979
	with modified operations at ERDF.											
	High dose materials (top 1 foot + shielding) containerized in B-25 boxes and shipped to ERDF											
	Medium dose soil (next 4 feet) blended at 1.2:1. Assume blended with 1 foot of shielding on top and 3.8 feet LLW material.									Subtotal		$ 31,580,108
	beneath the medium dose layer and shipped to ERDF.											
									G&A @ 3.89%			$ 1,228,466
										TOTAL:		$ 32,808,574

Table D-3. Option 4.

Item	Item Description	Equipment $	Materials $	Labor $	S/C $	Subtotal Direct	Distribs 25%	Home Office 3.00%	Profit 5.00%	B&O Tax 0.47%		Total Bid $
	Remove Panels & Beams	$ 33,230	$ 62,490	$ 239,382	$ 49,530	$ 384,632	$ 96,158	$ 14,424	$ 24,761	$ 2,444	$ -	$ 522,418
	Remove High Dose Concrete	$ 2,657	$ 78,180	$ 2,738	$ 585	$ 84,160	$ 21,040	$ 3,156	$ 5,418	$ 535	$ -	$ 114,309
	Remove LLW Concrete	$ 16,994	$ 534	$ 10,593	$ -	$ 28,121	$ 7,030	$ 1,055	$ 1,810	$ 179	$ -	$ 38,195
	Remove LLW Soil Above Boulders	$ 12,392	$ 16,602	$ 12,223	$ -	$ 41,217	$ 10,304	$ 1,546	$ 2,653	$ 262	$ -	$ 55,982
	Remove Boulders 1301 Crib	$ 53,069	$ 3,789,035	$ 71,265	$ 9,360	$ 3,922,729	$ 980,682	$ 147,102	$ 252,526	$ 24,924	$ -	$ 5,327,964
	High Dose Soil 1301 Crib & Trench	$ 18,001	$ 1,181,852	$ 23,101	$ 2,925	$ 1,225,880	$ 306,470	$ 45,970	$ 78,916	$ 7,789	$ -	$ 1,665,025
	High Dose Soil 1325 Crib & Trench	$ 56,929	$ 3,505,780	$ 71,508	$ 8,580	$ 3,642,797	$ 910,699	$ 136,605	$ 234,505	$ 23,146	$ -	$ 4,947,751
	Medium Dose Soil 1301 Crib & Trench	$ 176,165	$ 122,709	$ 159,755	$ 6,565	$ 465,194	$ 116,299	$ 17,445	$ 29,947	$ 2,956	$ -	$ 631,841
	Medium Dose Soil 1325 Crib & Trench	$ 155,756	$ 107,233	$ 140,956	$ 5,785	$ 409,730	$ 102,433	$ 15,365	$ 26,376	$ 2,603	$ -	$ 556,508
	Excavate Clean Overburden 1301	$ 13,866	$ -	$ 7,920	$ -	$ 21,786	$ 5,447	$ 817	$ 1,402	$ 138	$ -	$ 29,590
	Excavate Clean Overburden 1325	$ 6,941	$ -	$ 3,966	$ -	$ 10,907	$ 2,727	$ 409	$ 702	$ 69	$ -	$ 14,814
	Support Functions	$ 12,162	$ 120,863	$ 945,715	$ -	$ 1,078,740	$ 269,685	$ 40,453	$ 69,444	$ 6,854	$ -	$ 1,465,176
	Mobilization/Demobilization	$ 23,125	$ 246,447	$ 4,565	$ 118,000	$ 392,136	$ 98,034	$ 14,705	$ 25,244	$ 2,492	$ -	$ 532,611
	Subtotals:	$ 581,287	$ 9,231,726	$ 1,693,688	$ 201,330	$ 11,708,030	$ 2,927,008	$ 439,051	$ 753,704	$ 74,391	$ -	$ 15,902,184
	ERDF Disposal	$ 24,199	$ -	$ -	$ 19,299,850	$ 19,324,049						$ 19,324,049
	ERC Support	$ -	$ -	$ 1,422,617	$ 500,000	$ 1,922,617						$ 1,922,617
										Subtotal:		$ 37,148,850
	Option 4 Containerized shipments of High dose materials to Waste Management (RFSH) and blending of Medium dose materials for free dump with modified operations at ERDF.								Direct Distribs @ 18.49%			$ 6,868,822
	High dose materials (top 1 foot + shielding) containerized in B-25 boxes and shipped to RFSH.									Subtotal:		$ 44,017,672
	Medium dose soil (next 4 feet) blended at 1.2:1. Assume blended with 1 foot of shielding on top and 3.8 feet LLW material beneath the medium dose layer and shipped to ERDF.								G&A @ 3.89%			$ 1,712,287
										TOTAL:		$ 45,729,959

Table D-4. Option 5.

Item	Item Description	Equipment $	Materials $	Labor $	S/C $	Subtotal Direct	Distribs 25%	Home Office 3.00%	Profit 5.00%	B&O Tax 0.47%		Total Bid $
	Remove Panels & Beams	$ 33,230	$ 62,490	$ 239,382	$ 49,530	$ 384,632	$ 96,158	$ 14,424	$ 24,761	$ 2,444	$ -	$ 522,418
	Remove High Dose Concrete	$ 2,657	$ 78,180	$ 2,738	$ 585	$ 84,160	$ 21,040	$ 3,156	$ 5,418	$ 535	$ -	$ 114,309
	Remove LLW Concrete	$ 16,994	$ 534	$ 10,593	$ -	$ 28,121	$ 7,030	$ 1,055	$ 1,810	$ 179	$ -	$ 38,195
	remove LLW Soils Above Boulders	$ 12,392	$ 16,602	$ 12,223	$ -	$ 41,217	$ 10,304	$ 1,546	$ 2,653	$ 262	$ -	$ 55,982
	Remove Boulders 1301 Crib	$ 53,069	$ 3,789,035	$ 71,265	$ 9,360	$ 3,922,729	$ 980,682	$ 147,102	$ 252,526	$ 24,924	$ -	$ 5,327,964
	High Dose Soil 1301 Crib & Trench	$ 18,001	$ 1,181,852	$ 23,101	$ 2,925	$ 1,225,880	$ 306,470	$ 45,970	$ 78,916	$ 7,789	$ -	$ 1,665,025
	High Dose Soil 1325 Crib & Trench	$ 56,929	$ 3,505,780	$ 71,508	$ 8,580	$ 3,642,797	$ 910,699	$ 136,605	$ 234,505	$ 23,146	$ -	$ 4,947,751
	Medium Dose Soil 1301 Crib & Trench	$ 131,462	$ 9,216,223	$ 174,964	$ 22,620	$ 9,545,269	$ 2,386,317	$ 357,948	$ 614,477	$ 60,649	$ -	$ 12,964,659
	Medium Dose Soil 1325 Crib & Trench	$ 122,546	$ 8,474,722	$ 162,128	$ 20,865	$ 8,780,261	$ 2,195,065	$ 329,260	$ 565,229	$ 55,788	$ -	$ 11,925,603
	Excavate Clean Overburden 1301	$ 13,866	$ -	$ 7,920	$ -	$ 21,786	$ 5,447	$ 817	$ 1,402	$ 138	$ -	$ 29,590
	Excavate Clean Overburden 1325	$ 6,941	$ -	$ 3,966	$ -	$ 10,907	$ 2,727	$ 409	$ 702	$ 69	$ -	$ 14,814
	Support Functions	$ 13,246	$ 131,626	$ 927,284	$ -	$ 1,072,155	$ 268,039	$ 40,206	$ 69,020	$ 6,812	$ -	$ 1,456,232
	Mobilization/Demobilization	$ 23,125	$ 246,447	$ 4,565	$ 118,000	$ 392,136	$ 98,034	$ 14,705	$ 25,244	$ 2,492	$ -	$ 532,611
	Subtotals:	$ 504,457	$ 26,703,491	$ 1,711,636	$ 232,465	$ 29,152,049	$ 7,288,012	$ 1,093,202	$1,876,663	$ 185,227	$ -	$ 39,595,153
	ERDF Disposal	$ 1,352,562	$ -	$ -	$ 6,457,884	$ 7,810,446						$ 7,810,446
	ERC Support	$ -	$ -	$ 1,549,381	$ 500,000	$ 2,049,381						$ 2,049,381
										Subtotal		$ 43,454,980
	Option 5 Containerized shipments of both High dose and Medium dose materials to ERDF								Direct Distribs @ 18.49%			$ 9,144,226
	with modified operations at ERDF.											
	High dose materials (top 1 foot + shielding) containerized in B-25 boxes and shipped to ERDF.									Subtotal		$ 58,599,206
	Medium dose soil (next 4 feet) containerized in B-25 boxes and shipped to ERDF.											
									G&A @ 3.89%			$ 2,279,509
										TOTAL:		$ 60,878,715